Arlington Public Schools

ADDENDUM

ADDENDUM # 2 **DATE: November 11, 2011**

REFERENCE:	Invitation for Bid No.:	37FY12
	IFB Issue Date:	October 25, 2011
	Title:	Taylor Elementary School HVAC Renovation Project
	Architect/Engineer:	SHW Group LLP
	Sealed Bid Due Date:	November 18, 2011**,** before 2:00 PM

THE FOLLOWING CHANGES, ADDITIONS, DELETIONS AND CLARIFICATIONS ARE HEREBY MADE PART OF THE BIDDING REQUIREMENTS AND CONTRACT DOCUMENTS FOR THE ABOVE REFERENCED PROJECT AND SHALL BE TAKEN INTO ACCOUNT IN THE PREPARATION OF ALL BIDS AND THE EXECUTION OF ALL WORK. BIDDERS SHALL ACKNOWLEDGE RECEIPT OF THIS ADDENDUM IN THE APPROPRIATE SPACE ON THE BID FORM.

REQUESTS FOR INFORMATION:

PB #009: Specification Section 230010 General Conditions mechanical, Paragraph 1.01 H refers to specification sections 230900 and 230993. We do not have these spec sections. Please advise.

Answer: These spec sections have been issued by Automated Logic Controls and are included in this addendum. These sections are provided so the GC can coordinate with the controls contractor to provide a complete system. The controls contractor is under a separate contract with the Owner, refer to Specification Section 00700 General Conditions, Part 7.

PB #010: Spec Section 260533 sub section 3.1 calls for exposed conduit in mechanical rooms to be IMC. Can EMT be used in lieu of IMC?

Answer: The IMC conduit shall be used in the mechanical room, as specified.

PB #011: Are as-built drawings available for use in providing accurate demolition pricing?

Answer: Answered in Addendum #1.

PB #012: Please provide which roofing contractor carries the warranty on the existing roof if there is one.

Answer: Answered in Addendum #1.

PB #013: Are the existing steam tunnels going to be considered confined space?

Answer: The contractor is to verify the existing conditions affecting the work and shall comply as necessary, refer to Specification Section 00700 General Conditions, Part 12.

PB #014: Please provide drawings or details showing actual location of existing geothermal wells.

Answer: Refer to the as-built drawing G-1, issued in Addendum #1.

PB #015: Please provide drawings or details for geothermal circuit #5.

Answer: See revised sheet M5.1 included in this addendum.

PB #016: Page 2 of the invitation for bid scope of work advises the temperature controls contractor will be under a separate contract with APS. Can their scope of work be issued to coordinate with equipment vendors?

Answer: The controls Specification Sections 230900 and 230993 are included in this addendum.

PB #017: Does the existing RUDD AC unit get removed from the site per drawing A2.0?

Answer: Yes, all the existing split AC units shall be removed.

PB #018: The IFB Page 3 indicates the contractor shall work during unoccupied hours such as nights & weekends until total building is available for construction on June 25th 2012. Can work in the mechanical room be done on normal hours since this area is accessible without entering the building?

Answer: Yes, but this work must be coordinated and approved in advance by Arlington Public Schools and the school administration.

PB #019: General Conditions Section 00700 page 15 section 5.9 E states there will need to be a chain link fence to enclose the construction area. Will this only be required at the contractor's temporary facilities and storage area?

Answer: Yes, the area is defined on sheet G0.0.

PB #020: Is the name of the geothermal contractor that performed the original installation of the wells and piping available?

Answer: Yes, it is Thermal Loop Corporation. www.thermalloopcorp.com

DRAWINGS:

FULL SIZE DRAWINGS - SEE ATTACHMENT "A"

Architectural:

1. **SHEET G0.0: Revise** "Milestone Schedule" to show August 13 as the date of Substantial Completion.
   Revise "Milestone Schedule" to show August 31 as the date of Final Completion.

Mechanical:

1. **SHEET M2.1**
2. **SHEET M2.2**
3. **SHEET M3.1**
4. **SHEET M5.1**

SPECIFICATIONS:

FULL SPEC SECTIONS - SEE ATTACHMENT "B"

SECTION 000001 – TABLE OF CONTENTS

a. **Add** category "SPECIFICATIONS FOR INSTRUMENTATION AND CONTROL FOR HVAC (SEPARATE CONTRACT"
b. **Add** section "230923 DIRECT – DIGITAL CONTROL SYSTEM FOR HVAC"
c. **Add** section "230993 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS"

SECTION 00400 – AGREEMENT BETWEEN OWNER AND CONTRACTOR

a. **Revise** paragraph 5.6 to read "Substantial Completion of the Project – August 13th, 2012."
b. **Revise** paragraph 5.7 to read "Final Completion of the Project – August 31st, 2012."

SECTION 00420 – BID FORM

a. **Revise** paragraph 8.a.5 to read "Substantial Completion of the Project – August 13th, 2012."
b. **Revise** paragraph 8.a.6 to read "Final Completion of the Project – August 31st, 2012."
c. **Revise** paragraph 13, BID ITEM 3, see attached specification.
d. **Add** BID ITEM 4: UNIT PRICES to paragraph 13, see attached specification.

SECTION 024119 – SELECTIVE DEMOLITION

a. **Revise** paragraph 3.3.B.4 to read “Cover and protect furniture, furnishings, and equipment that have not been removed, including wall mounted interactive white boards and ceiling mounted projectors.”

SECTION 230010 - GENERAL CONDITIONS – MECHANICAL

SECTION 230519 – THERMOMETERS

SECTION 230520 - PRESSURE GAUGE

SECTION 230523 – VALVES

SECTION 230524 - HYDRONIC SPECIALTIES

SECTION 232113.33 - GEOTHERMAL SYSTEM

SECTION 235216 - CONDENSING BOILER

SECTION 236500 - COOLING TOWER

SECTION 237200 - ENERGY RECOVERY HEAT PUMP UNIT

SECTION 238146 - HEAT PUMP SYSTEM CLOSED CIRCUIT

SPECIFICATIONS (UNDER SEPARATE CONTRACT):

FULL SPEC SECTIONS - SEE ATTACHMENT “C”

SECTION 230923 - DIRECT – DIGITAL CONTROL SYSTEM FOR HVAC (UNDER SEPARATE CONTRACT)

a. **Added** in its entirety

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS (UNDER SEPARATE CONTRACT)

a. **Added** in its entirety

ATTACHMENTS:

ATTACHMENT “A”

FULL SIZE SHEETS: M2.1, M2.2, M3.1, M5.1

ATTACHMENT “B”

FULL SPECIFICATION SECTIONS: 00420 BID FORM, 230923 DIRECT – DIGITAL CONTROL SYSTEM FOR HVAC, 230993 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS, 230010 - GENERAL CONDITIONS – MECHANICAL, 230519 – THERMOMETERS, 230520 - PRESSURE GAUGE, 230523 – VALVES, 230524 - HYDRONIC SPECIALTIES, 232113.33 - GEOTHERMAL SYSTEM, 235216 - CONDENSING BOILER, 236500 - COOLING TOWER, 237200 - ENERGY RECOVERY HEAT PUMP UNIT, 238146 - HEAT PUMP SYSTEM CLOSED CIRCUIT,

ATTACHMENT “C”

FULL SPECIFICATION SECTIONS (UNDER SEPARATE CONTRACT): 230923 DIRECT – DIGITAL CONTROL SYSTEM FOR HVAC, 230993 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

END OF ADDENDUM # 2

ATTACHMENT “A”

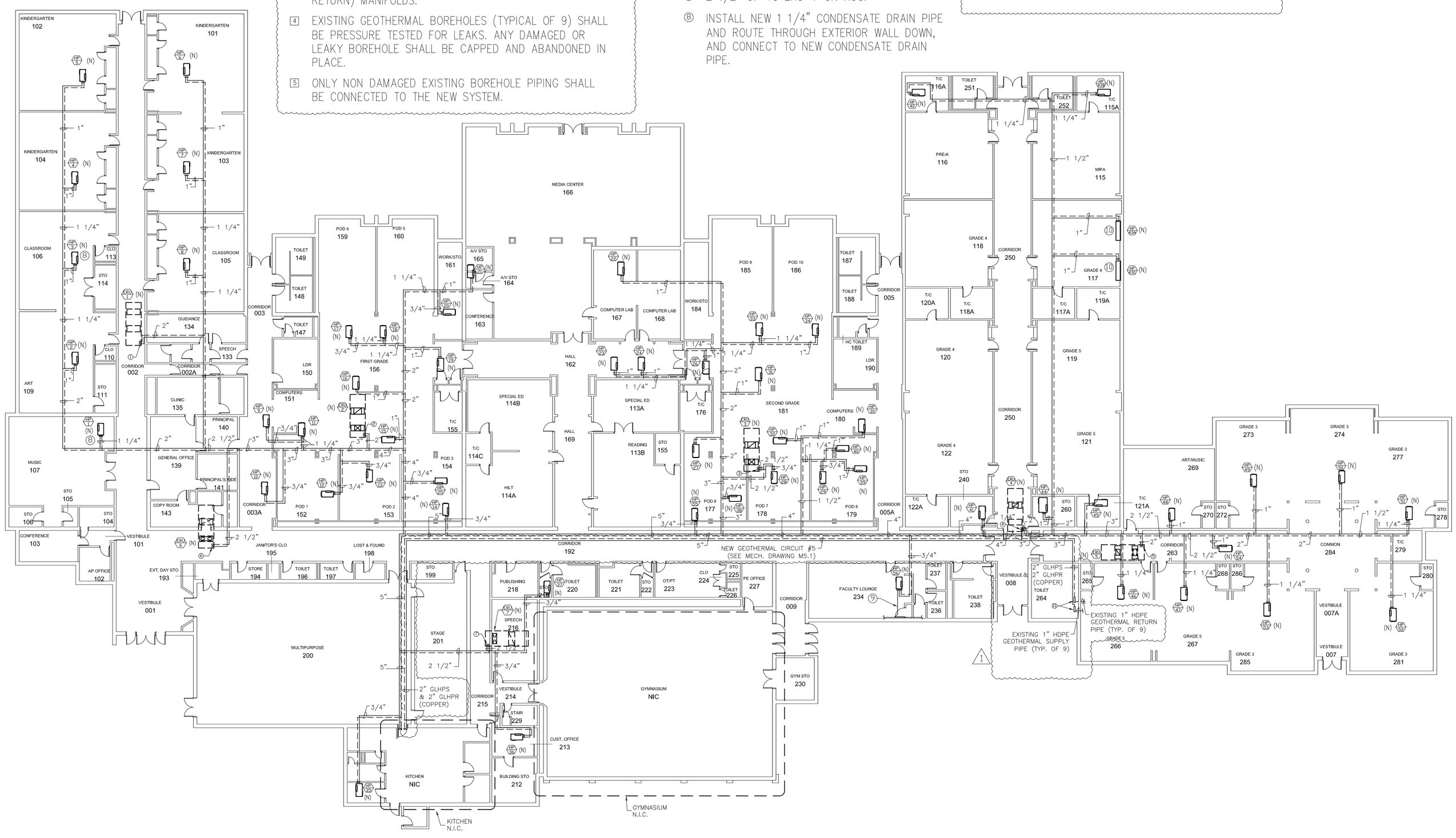
FULL SIZE SHEETS:
M2.1, M2.2, M3.1, M5.1

GENERAL NOTES:

1. INSTALL NEW CONDENSATE DRAIN. EXISTING CONDENSATE DRAIN SHALL BE REMOVED. FOLLOW EXISTING CONDENSATE ROUTE. PROVIDE 1/4" SLOPE (MIN).
2. PROVIDE FIRE STOPPING AT FIRE RATED WALLS.
3. EXISTING GEOTHERMAL PIPING FROM 9 BOREHOLES SHALL BE DISCONNECTED FROM EXISTING CONSOLE UNITS AND SHALL BE EXTENDED TO NEW COPPER (SUPPLY & RETURN) MANIFOLDS. 1
4. EXISTING GEOTHERMAL BOREHOLES (TYPICAL OF 9) SHALL BE PRESSURE TESTED FOR LEAKS. ANY DAMAGED OR LEAKY BOREHOLE SHALL BE CAPPED AND ABANDONED IN PLACE.
5. ONLY NON DAMAGED EXISTING BOREHOLE PIPING SHALL BE CONNECTED TO THE NEW SYSTEM.

NOTES:

① 2" UP TO ERU-1 ON ROOF
② 2" UP TO ERU-2 ON ROOF
③ 2 1/2" UP TO ERU-3 ON ROOF
④ 2" UP TO ERU-4 ON ROOF
⑤ 2" UP TO ERU-5 ON ROOF
⑥ 2 1/2" UP TO ERU-6 ON ROOF
⑦ 2 1/2" UP TO ERU-7 ON ROOF
⑧ INSTALL NEW 1 1/4" CONDENSATE DRAIN PIPE AND ROUTE THROUGH EXTERIOR WALL DOWN, AND CONNECT TO NEW CONDENSATE DRAIN PIPE.
⑨ INSTALL NEW 1 1/4" CONDENSATE DRAIN PIPE AND CONNECT TO NEW CONDENSATE DRAIN PIPE.
⑩ DRAIN CONDENSATE THROUGH EXTERIOR WALL AND TURN DOWN OVER GRASS.
⑪ CONNECT EXISTING 1" (9 SUPPLY AND 9 RETURN) TO NEW COPPER MANIFOLD ABOVE CEILING. PROVIDE TWO (2) 12"x12" ACCESS PANELS IN CEILING. 1



1 MECHANICAL - HVAC PIPING PLAN
1/16" = 1'-0"

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10-14-2011

ARLINGTON PUBLIC SCHOOLS

TAYLOR ELEMENTARY SCHOOL
HVAC RENOVATION

2600 North Stuart Street
Arlington, Virginia 22207

DRAWN: MM
CHECKED: TS
SCALE: 1/16" = 1'0"
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ISSUE: October 14, 2011

1	11/1/2011	ADDENDUM #2

AREA A | AREA B | AREA C | AREA D

KEY PLAN [NTS]

SHEET TITLE:
MECHANICAL - HVAC PIPING PLAN

M2.1

SHW Project: 3111.003.00

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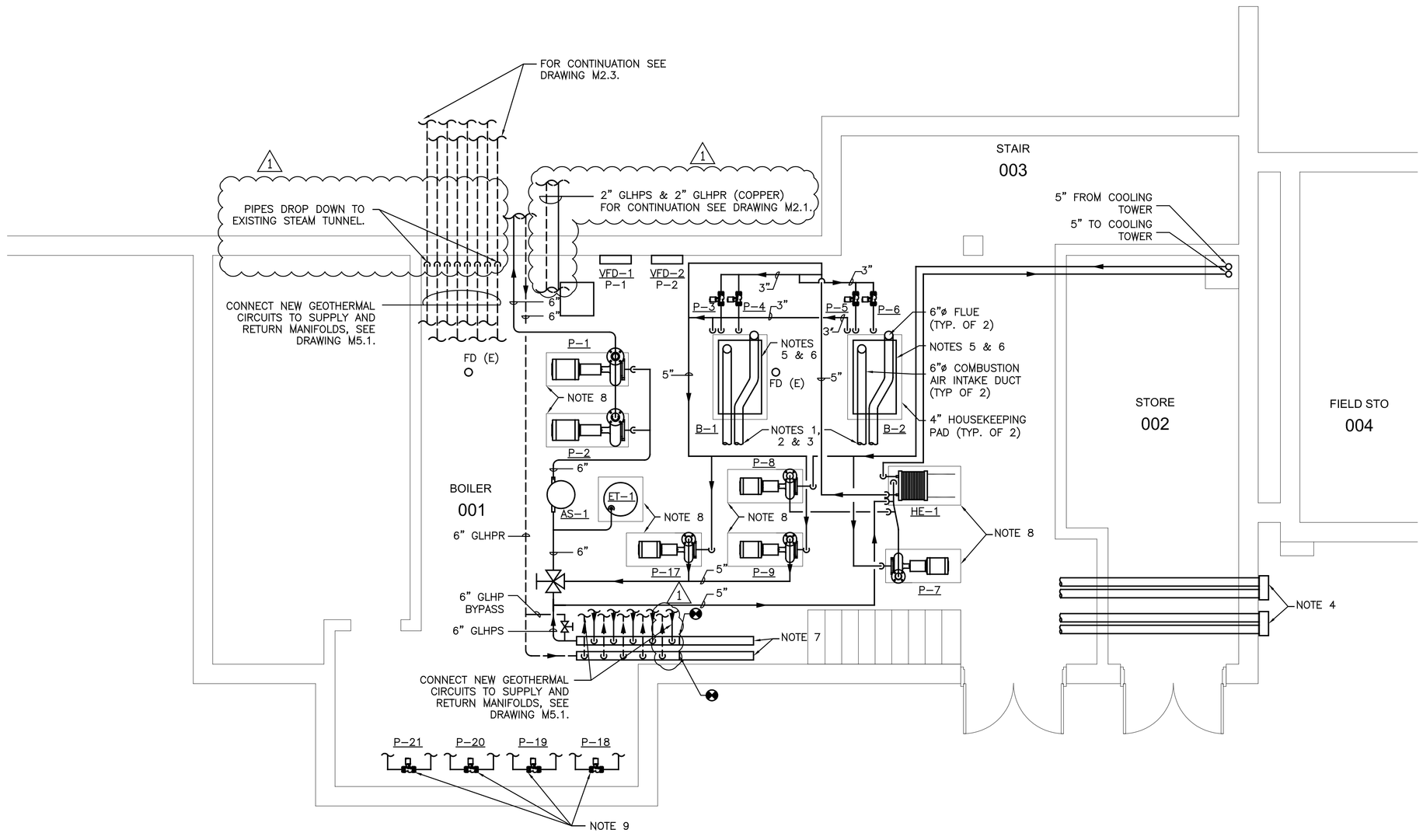

1 BASEMENT - MECHANICAL ROOM - HVAC PIPING PLAN

1/4" = 1'-0"

NOTES:

1. COMBUSTION AIR INTAKE AND EXHAUST DUCT OUTLETS (TYP. OF 2), SHALL BE CONNECTED TO SIDEWALL VENT TERMINATION KIT. CONTRACTOR SHALL COORDINATE SIDEWALL VENT TERMINATION KIT WITH SITE CONDITION. COMPLY WITH CODE AND MANUFACTURER'S REQUIREMENTS.
2. 6" COMBUSTION AIR INTAKE AND 6" EXHAUST DUCTWORKS SHALL BE LOCATED TIGHT AGAINST CEILING SLAB.
3. PROVIDE PVC OR AL29-4C VENT MATERIAL.
4. SIDEWALL VENT TERMINATION KIT SHALL BE SUPPLIED BY BOILER MANUFACTURER.
5. EXTEND BOILERS (B-1 & B-2) CONDENSATE PIPE TO EXISTING OPEN FLOOR DRAIN.
6. GAS CONNECTION – 1 1/2".
7. EXISTING GEOTHERMAL SUPPLY AND RETURN HEADERS SHALL REMAIN. EXTEND EXISTING SUPPLY AND RETURN MANIFOLDS BY MINIMUM OF 48".
8. PROVIDE 4" HOUSE KEEPING PAD (TYPICAL). SEE STRUCTURAL DRAWINGS FOR CONSTRUCTION.
9. SEE DRAWING M5.1 FOR P-18, P-19, P-20 & P-21 CONNECTIONS.

DEMOLITION NOTES:

1. REMOVE EXISTING GEOTHERMAL PUMPS AND ASSOCIATED EXISTING PIPING AND HYDRONIC SPECIALITIES (AIR SEPARATORS, EXPANSION TANKS, ETC) WITHIN THE MECHANICAL ROOM.
2. EXISTING DOMESTIC HOT WATER SYSTEM TO REMAIN.

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TAYLOR ELEMENTARY SCHOOL
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2600 North Stuart Street
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DRAWN: **MM**
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SCALE: **1/4" = 1'0"**
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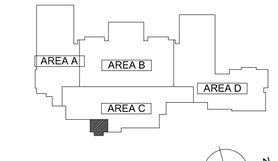
1	11/11/2011	ADDENDUM #2



KEY PLAN [NTS]

SHEET TITLE:

BASEMENT-MECHANICAL ROOM - HVAC PIPING PLAN

M2.2

SHW Project: **3111.003.00**

WATER SOURCE GEOTHERMAL HEAT PUMP SCHEDULE

Unit Designation	Configuration	FAN			COOLING										HEATING						ELECTRICAL DATA				GPM	Max Water PD FT	Refrigerant Type	Supply Air Arrangement	Return Air Arrangement	"Basis of Design "Trane""
		CFM Total Cooling / Heating	Speed	"ESP in wg"	EER @ ARI	COP @ ARI	Capacity			EAT		LAT		Water		Compressor Power	Capacity		Water		EAT	EAT	Volts/ Phase	FLA	MCA	MAX Fuse						
							MBH Total	MBH Sensible	Heat of rejection	F db	F wb	F db	F wb	F EWT	F LWT		MBH capacity	MBH Absorp	F EWT	F LWT	F db	F db										
HP-1	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Back	Right	EXHE030
HP-2	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Left	Right	EXHE030
HP-3	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Left	Right	EXHE030
HP-4	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Left	Right	EXHE030
HP-5	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Left	Right	EXHE030
HP-6	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Right	Left	EXHE030
HP-7	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Right	Left	EXHE030
HP-8	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Right	Left	EXHE030
HP-9	Horizontal	855	High	0.43	15.0	4.70	21.55	17.75	27.52	75.0	62.0	55.61	52.98	85.0	100.29	1.75	21.76	16.42	50.0	40.88	70.0	93.8	265/1/60	10.1	12.35	20.0	3.60	5.32	R-410a	Left	Right	EXHE024
HP-10	Horizontal	650	High	0.50	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Left	Right	EXHE018
HP-11	Horizontal	1075	Med	0.50	15.9	5.30	32.33	26.15	40.60	75.0	62.0	54.05	51.99	85.0	97.85	2.42	34.61	26.42	50.0	41.64	70.0	97.7	265/1/60	15.7	18.75	30.0	6.32	6.25	R-410a	Back	Right	EXHE036
HP-12	Horizontal	665	High	0.51	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Back	Right	EXHE018
HP-13	Horizontal	660	High	0.51	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Back	Right	EXHE018
HP-14	Horizontal	660	High	0.51	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Back	Right	EXHE018
HP-15	Horizontal	1060	Med	0.50	15.9	5.30	31.61	24.52	40.02	75.0	62.0	53.17	51.03	85.0	99.55	2.46	33.73	25.28	50.0	40.81	70.0	100.0	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-16	Horizontal	1060	Med	0.50	15.9	5.30	31.61	24.52	40.02	75.0	62.0	53.17	51.03	85.0	99.55	2.46	33.73	25.28	50.0	40.81	70.0	100.0	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-17	Horizontal	880	High	0.39	15.0	4.70	21.55	17.75	27.52	75.0	62.0	55.61	52.98	85.0	100.29	1.75	21.76	16.42	50.0	40.88	70.0	93.8	265/1/60	10.1	12.35	20.0	3.60	5.32	R-410a	Back	Right	EXHE024
HP-18	Horizontal	1030	Med	0.50	15.9	5.30	31.98	24.63	40.03	75.0	62.0	53.08	50.89	85.0	94.50	2.36	35.05	26.53	50.0	43.71	70.0	101.2	265/1/60	15.7	18.75	30.0	8.43	10.29	R-410a	Back	Right	EXHE036
HP-19	Horizontal	1220	High	0.50	15.9	5.30	32.71	27.55	41.11	75.0	62.0	54.94	52.87	85.0	99.95	2.46	34.07	26.18	50.0	40.48	70.0	94.8	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	GEHE036
HP-20	Horizontal	880	High	0.39	15.0	4.70	21.55	17.75	27.52	75.0	62.0	55.61	52.98	85.0	100.29	1.75	21.76	16.42	50.0	40.88	70.0	93.8	265/1/60	10.1	12.35	20.0	3.60	5.32	R-410a	Back	Right	GEHE024
HP-21	Horizontal	1060	Med	0.50	15.9	5.30	31.61	24.52	40.02	75.0	62.0	53.17	51.03	85.0	99.55	2.46	33.73	25.28	50.0	40.81	70.0	100.0	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-22	Horizontal	1060	Med	0.50	15.9	5.30	31.61	24.52	40.02	75.0	62.0	53.17	51.03	85.0	99.55	2.46	33.73	25.28	50.0	40.81	70.0	100.0	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-23	Horizontal	1060	Med	0.50	15.9	5.30	31.61	24.52	40.02	75.0	62.0	53.17	51.03	85.0	99.55	2.46	33.73	25.28	50.0	40.81	70.0	100.0	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-24	Horizontal	1060	Med	0.50	15.9	5.30	31.61	24.52	40.02	75.0	62.0	53.17	51.03	85.0	99.55	2.46	33.73	25.28	50.0	40.81	70.0	100.0	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-25	Horizontal	840	High	0.45	15.0	4.70	21.55	17.75	27.52	75.0	62.0	55.61	52.98	85.0	100.29	1.75	21.76	16.42	50.0	40.88	70.0	93.8	265/1/60	10.1	12.35	20.0	3.60	5.32	R-410a	Back	Right	EXHE024
HP-26	Horizontal	1260	High	0.47	15.9	5.30	32.71	27.55	41.11	75.0	62.0	54.94	52.87	85.0	99.95	2.46	34.07	26.18	50.0	40.48	70.0	94.8	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-27	Horizontal	1320	High	0.33	15.9	5.30	32.71	27.55	41.11	75.0	62.0	54.94	52.87	85.0	99.95	2.46	34.07	26.18	50.0	40.48	70.0	94.8	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-28	Horizontal	660	High	0.51	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Back	Right	EXHE018
HP-29	Horizontal	660	High	0.51	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Back	Right	EXHE018
HP-30	Horizontal	1075	Med	0.50	15.9	5.30	32.33	26.15	40.60	75.0	62.0	54.05	51.99	85.0	97.85	2.42	34.61	26.42	50.0	41.64	70.0	97.7	265/1/60	15.7	18.75	30.0	6.32	6.25	R-410a	Back	Right	EXHE036
HP-31	Horizontal	1060	Med	0.50	15.9	5.30	31.61	24.52	40.02	75.0	62.0	53.17	51.03	85.0	99.55	2.46	33.73	25.28	50.0	40.81	70.0	100.0	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-32	Horizontal	1060	Med	0.50	15.9	5.30	31.61	24.52	40.02	75.0	62.0	53.17	51.03	85.0	99.55	2.46	33.73	25.28	50.0	40.81	70.0	100.0	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Back	Right	EXHE036
HP-33	Horizontal	1030	Med	0.50	15.9	5.30	31.98	24.63	40.03	75.0	62.0	53.08	50.89	85.0	94.50	2.36	35.05	26.53	50.0	43.71	70.0	101.2	265/1/60	15.7	18.75	30.0	8.43	10.29	R-410a	Left	Right	EXHE036
HP-34	Horizontal	880	High	0.39	15.0	4.70	21.55	17.75	27.52	75.0	62.0	55.61	52.98	85.0	100.29	1.75	21.76	16.42	50.0	40.88	70.0	93.7	265/1/60	10.1	12.35	20.0	3.60	5.32	R-410a	Left	Right	EXHE024
HP-35	Horizontal	1320	High	0.33	15.9	5.30	32.71	27.55	41.11	75.0	62.0	54.94	52.87	85.0	99.95	2.46	34.07	26.18	50.0	40.48	70.0	94.8	265/1/60	15.7	18.75	30.0	5.50	4.88	R-410a	Left	Right	EXHE036
HP-36	Horizontal	600	High	0.27	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Left	Right	EXHE018
HP-37	Horizontal	600	High	0.27	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.43	15.0	2.70	3.51	R-410a	Back	Left	EXHE018
HP-38	Horizontal	600	High	0.27	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.43	15.0	2.70	3.51	R-410a	Left	Right	EXHE018
HP-39	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Back	Right	EXHE030
HP-40	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Back	Right	EXHE030
HP-41	Horizontal	1000	Low	0.51	15.9	5.30	32.07	24.68	40.03	75.0	62.0	53.04	50.85	85.0	93.27	2.33	35.38	26.84	50.0	44.45	70.0	101.5	265/1/60	15.7	18.75	30.0	9.68	13.10	R-410a	Right	Left	EXHE036
HP-42	Horizontal	1000	Low	0.51	15.9	5.30	32.07	24.68	40.03	75.0	62.0	53.04	50.85	85.0	93.27	2.33	35.38	26.84	50.0	44.45	70.0	101.5	265/1/60	15.7	18.75	30.0	9.68	13.10	R-410a	Right	Right	EXHE036
HP-43a,c	Console	480	n/a	0.20	14.5	4.60	14.40	11.60	18.00	75.0	62.0	53.70	50.60	85.0	94.60	1.56	15.70	12.30	50.0	44.45	70.0	104.8	265/1/60	7.1	8.70	15.0	4.20	18.00	R-410a	Top	Front	GECE015
HP-43b	Horizontal	1000	Low	0.51	15.9	5.30	32.07	24.68	40.03	75.0	62.0	53.04	50.85	85.0	93.27	2.33	35.38	26.84	50.0	44.45	70.0	101.5	265/1/60	15.7	18.75	30.0	9.68	13.10	R-410a	Right	Right	EXHE036
HP-44	Horizontal	1440	High	0.60	15.5	5.30	42.90	34.62	54.75	75.0	62.0	54.20	52.04	85.0	100.00	3.47	45.84	34.84	50.0	40.46	70.0	97.5	460/3/60	10.5	12.03	15.0	7.30	4.73	R-410a	Left	Right	EXHE048
HP-45	Horizontal	1000	Low	0.51	15.9	5.30	32.07	24.68	40.03	75.0	62.0	53.04	50.85	85.0	93.27	2.33	35.38	26.84	50.0	44.45	70.0	101.5	265/1/60	15.7	18.75	30.0	9.68	13.10	R-410a	Left	Right	EXHE036
HP-46	Horizontal	1000	Low	0.51	15.9	5.30	32.07	24.68	40.03	75.0	62.0	53.04	50.85	85.0	93.27	2.33	35.38	26.84	50.0	44.45	70.0	101.5	265/1/60	15.7	18.75	30.0	9.68	13.10	R-410a	Back	Left	EXHE036
HP-47	Horizontal	1000	Low	0.51	15.9	5.30	32.07	24.68	40.03	75.0	62.0	53.04	50.85	85.0	93.27	2.33	35.38	26.84	50.0	44.45	70.0	101.5	265/1/60	15.7	18.75	30.0	9.68	13.10	R-410a	Back	Left	EXHE036
HP-48	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Back	Left	EXHE030
HP-49	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Back	Left	EXHE030
HP-50	Horizontal	1000	High	0.17	15.5	5.30	27.51	23.67	34.64	75.0	62.0	54.31	52.77	85.0	98.17	2.09	28.60	22.04	50.0	41.62	70.0	95.0	265/1/60	13.7	16.43	25.0	5.26	8.21	R-410a	Back	Left	EXHE030
HP-51	Horizontal	1200	High	0.58	15.5	5.30	41.71	30.50	53.00	75.0	62.0	52.10	49.63	85.0	93.98	3.31	46.58	34.58	50.0	44.14	70.0	105.0	460/3/60	10.5	12.03	15.0	11.80	10.86	R-410a	Back	Left	EXHE042
HP-52	Horizontal	1200	High	0.58	15.5	5.30	41.71	30.50	53.00	75.0	62.0	52.10	49.63	85.0	93.98	3.31	46.58	34.58	50.0	44.14	70.0	105.0	460/3/60	10.5	12.03	15.0	11.80	10.86	R-410a	Back	Right	EXHE042
HP-53	Horizontal	1000	Low	0.51	15.9	5.30	32.07	24.68	40.03	75.0	62.0	53.04	50.85	85.0	93.27	2.33	35.38	26.84	50.0	44.45	70.0	101.5	265/1/60	15.7	18.75	30.0	9.68	13.10	R-410a	Back	Left	EXHE036
HP-54	Horizontal	1075	Med	0.50	15.9	5.30	32.33	26.15	40.60	75.0	62.0	54.05	51.99	85.0	97.85	2.42	34.61	26.42	50.0	41.64	70.0	97.7	265/1/60	15.7	18.75	30.0	6.32	6.25	R-410a	Back	Left	EXHE036
HP-55	Horizontal	660	High	0.51	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Back	Right	EXHE018
HP-56	Horizontal	660	High	0.51	15.5	5.10	17.00	14.41	21.56	75.0	62.0	54.01	52.47	85.0	100.97	1.33	17.60	13.41	50.0	40.07	70.0	95.6	265/1/60	9.0	10.93	15.0	2.70	3.51	R-410a	Back	Right	EXHE018

NOTES:

1. DISCONNECT TO BE PROVIDED AND INSTALLED BY THE MANUFACTURER.
2. PERFORMANCE IS BASED ON 100% WATER
3. MINIMUM ACCEPTABLE EFFICIENCIES ARE NOTED IN THE SCHEDULE ABOVE (EER AND COP VALUES)
4. MECHANICAL CONTRACTOR SHALL COMPLY WITH MANUFACTURER'S CLEARANCE REQUIREMENTS. FOR THE TRANE UNITS (BASIS OF DESIGN) CLEARANCES ARE 18" ON THE FRONT, RIGHT AND BACK SIDES OF UNIT, AND 3" CLEARANCE ON LEFT SIDE OF UNIT. IF SUPPLY OR RETURN IS NOT LOCATED ON LONG SIDE OF UNIT CLEARANCE PROVIDE 2" CLEARANCE ON THIS SIE OF UNIT.

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10-14-2011

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TAYLOR ELEMENTARY SCHOOL
HVAC RENOVATION

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CHECKED: TS
SCALE: NO SCALE
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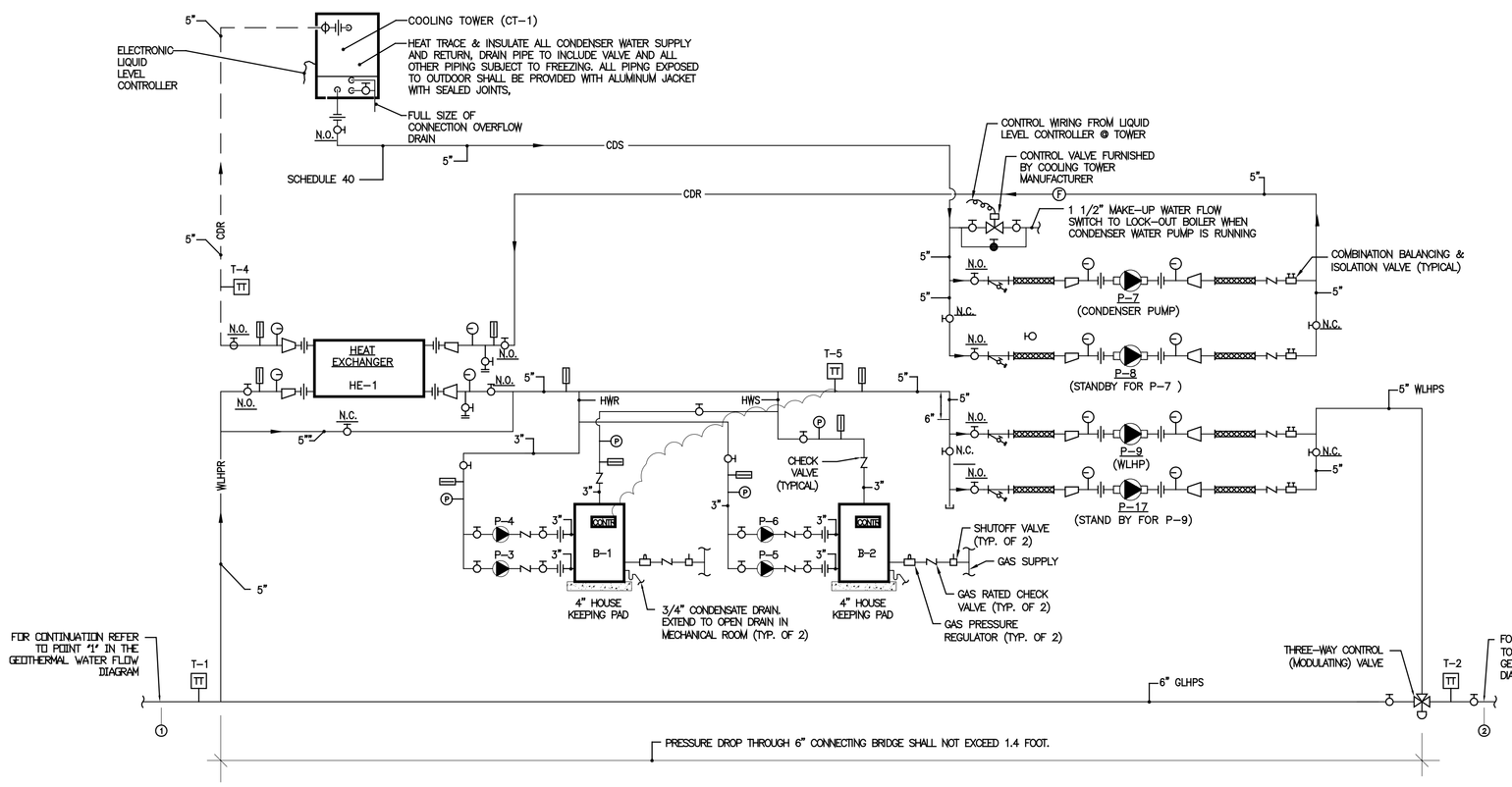
ISSUE: October 14, 2011

1	11/11/2011	ADDENDUM #2

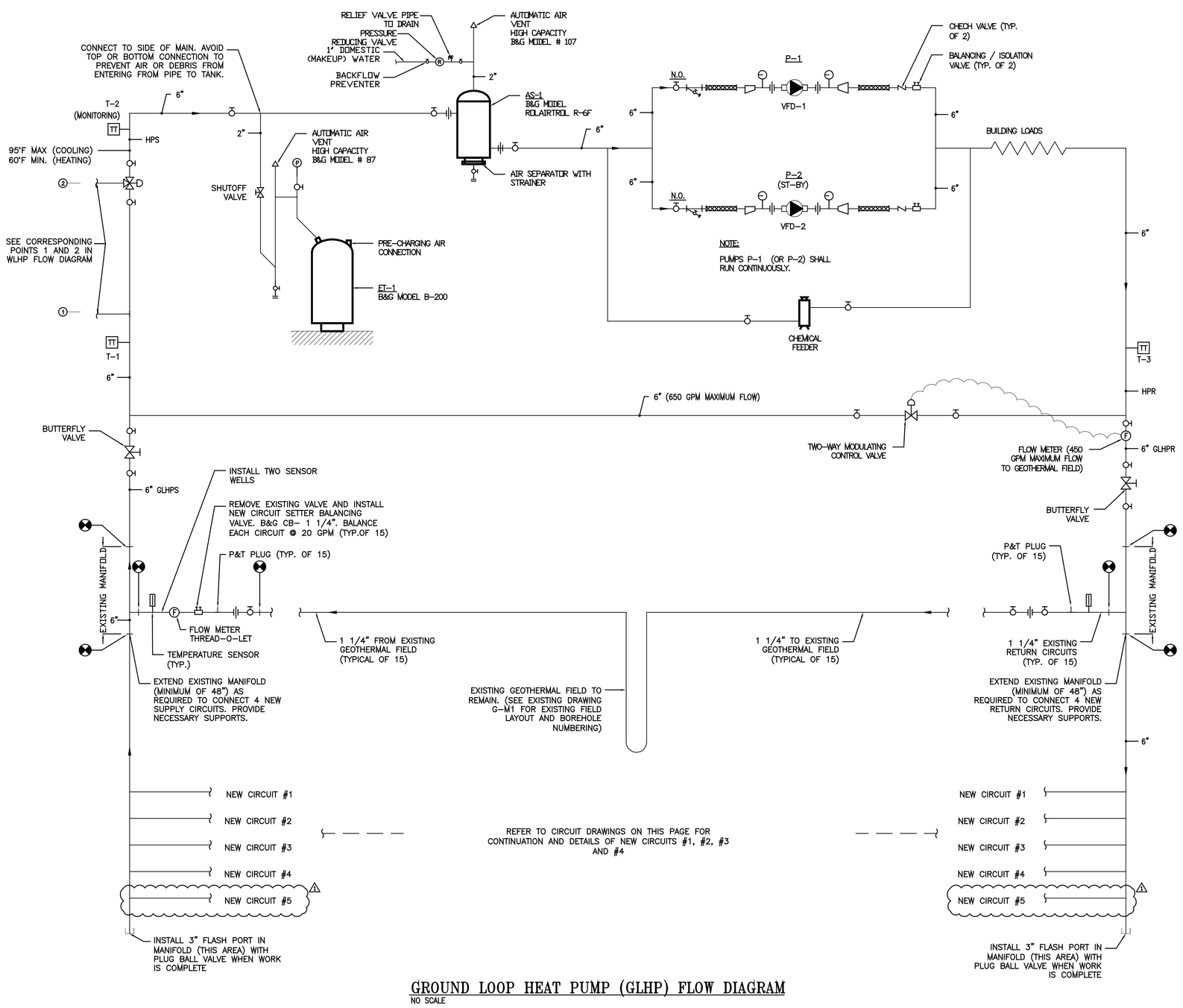
SHEET TITLE:
MECHANICAL SCHEDULES

SHW Project: 3111.003.00

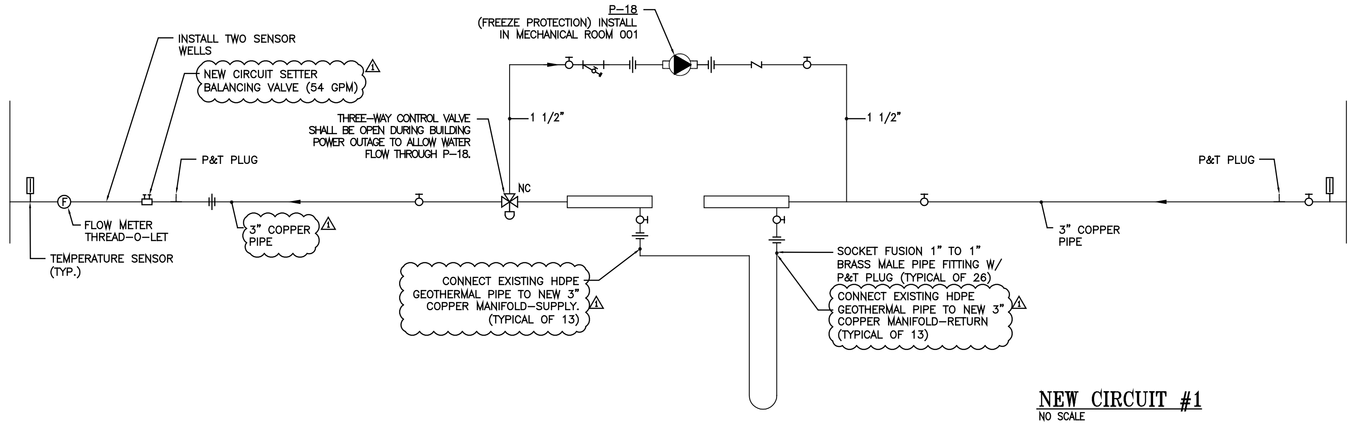
M3.1


COOLING TOWER (CT-1)
ELECTRONIC LIQUID LEVEL CONTROLLER
HEAT TRACE & INSULATE ALL CONDENSER WATER SUPPLY AND RETURN, DRAIN PIPE TO INCLUDE VALVE AND ALL OTHER PIPING SUBJECT TO FREEZING. ALL PIPING EXPOSED TO OUTDOOR SHALL BE PROVIDED WITH ALUMINUM JACKET WITH SEALED JOINTS.
FULL SIZE OF CONNECTION OVERFLOW DRAIN
SCHEDULE 40
CDS
CDR
CONTROL WIRING FROM LIQUID LEVEL CONTROLLER @ TOWER
CONTROL VALVE FURNISHED BY COOLING TOWER MANUFACTURER
1 1/2" MAKE-UP WATER FLOW SWITCH TO LOCK-OUT BOILER WHEN CONDENSER WATER PUMP IS RUNNING
COMBINATION BALANCING & ISOLATION VALVE (TYPICAL)
P-7 (CONDENSER PUMP)
P-8 (STANDBY FOR P-7)
P-9 (WLHP)
P-17 (STAND BY FOR P-9)
5" WLHPS
HEAT EXCHANGER HE-1
HWR
HWS
WLHPR
CHECK VALVE (TYPICAL)
SHUTOFF VALVE (TYP. OF 2)
GAS SUPPLY
GAS RATED CHECK VALVE (TYP. OF 2)
GAS PRESSURE REGULATOR (TYP. OF 2)
B-1
B-2
4" HOUSE KEEPING PAD
3/4" CONDENSATE DRAIN. EXTEND TO OPEN DRAIN IN MECHANICAL ROOM (TYP. OF 2)
T-1
T-2
T-3
T-4
T-5
THREE-WAY CONTROL (MODULATING) VALVE
FOR CONTINUATION REFER TO POINT "1" IN THE GEOTHERMAL WATER FLOW DIAGRAM
FOR CONTINUATION REFER TO POINT "2" IN THE GEOTHERMAL WATER FLOW DIAGRAM
6" GLHPS
PRESSURE DROP THROUGH 6" CONNECTING BRIDGE SHALL NOT EXCEED 1.4 FOOT.

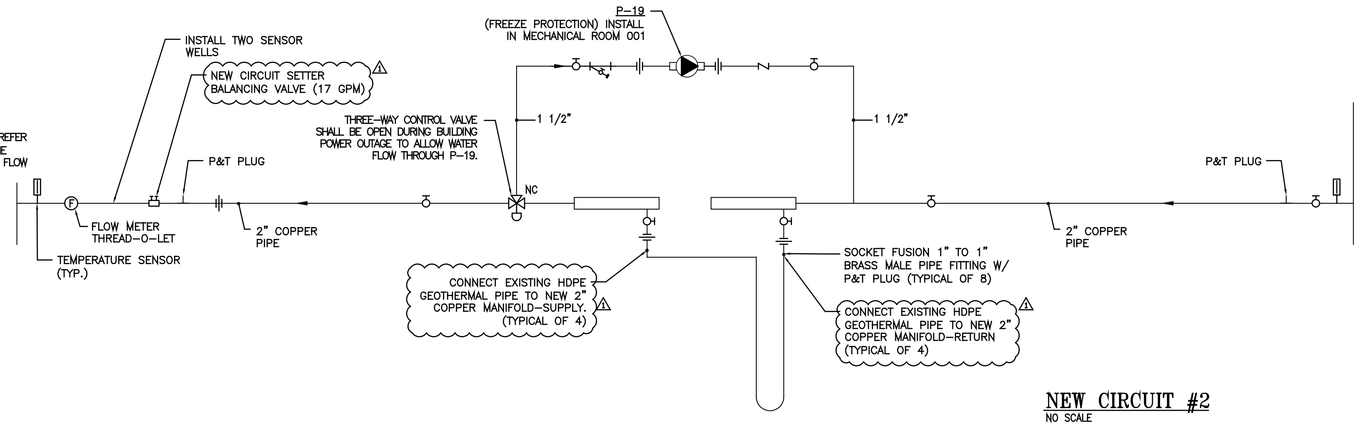
WATER-LOOP HEAT PUMP (WLHP) FLOW DIAGRAM
NO SCALE


CONNECT TO SIDE OF MAIN. AVOID TOP OR BOTTOM CONNECTION TO PREVENT AIR OR DEBRIS FROM ENTERING FROM PIPE TO TANK.
RELIEF VALVE PIPE TO DRAIN
PRESSURE-REDUCING VALVE 1" DOMESTIC (MAKEUP) WATER
BACKFLOW PREVENTER
AUTOMATIC AIR VENT HIGH CAPACITY B&G MODEL # 107
AS-1 B&G MODEL ROLAIRTROL R-6F
AUTOMATIC AIR VENT HIGH CAPACITY B&G MODEL # 87
AIR SEPARATOR WITH STRAINER
SHUTOFF VALVE
PRE-CHARGING AIR CONNECTION
ET-1 B&G MODEL B-200
T-2 (MONITORING)
95°F MAX (COOLING) 60°F MIN. (HEATING)
HPS
SEE CORRESPONDING POINTS 1 AND 2 IN WLHP FLOW DIAGRAM
P-1
P-2
VFD-1
VFD-2
CHECK VALVE (TYP. OF 2)
BALANCING / ISOLATION VALVE (TYP. OF 2)
BUILDING LOADS
NOTE: PUMPS P-1 (OR P-2) SHALL RUN CONTINUOUSLY.
CHEMICAL FEEDER
T-1
T-3
6" (650 GPM MAXIMUM FLOW)
HPR
BUTTERFLY VALVE
TWO-WAY MODULATING CONTROL VALVE
FLOW METER (450 GPM MAXIMUM FLOW TO GEOTHERMAL FIELD)
6" GLHPR
6" GLHPS
INSTALL TWO SENSOR WELLS
REMOVE EXISTING VALVE AND INSTALL NEW CIRCUIT SETTER BALANCING VALVE. B&G CB- 1 1/4". BALANCE EACH CIRCUIT @ 20 GPM (TYP.OF 15)
P&T PLUG (TYP. OF 15)
EXISTING MANIFOLD
FLOW METER THREAD-O-LET
TEMPERATURE SENSOR (TYP.)
1 1/4" FROM EXISTING GEOTHERMAL FIELD (TYPICAL OF 15)
EXTEND EXISTING MANIFOLD (MINIMUM OF 48") AS REQUIRED TO CONNECT 4 NEW SUPPLY CIRCUITS. PROVIDE NECESSARY SUPPORTS.
EXISTING GEOTHERMAL FIELD TO REMAIN. (SEE EXISTING DRAWING G-M1 FOR EXISTING FIELD LAYOUT AND BOREHOLE NUMBERING)
1 1/4" TO EXISTING GEOTHERMAL FIELD (TYPICAL OF 15)
1 1/4" EXISTING RETURN CIRCUITS (TYP. OF 15)
EXTEND EXISTING MANIFOLD (MINIMUM OF 48") AS REQUIRED TO CONNECT 4 NEW RETURN CIRCUITS. PROVIDE NECESSARY SUPPORTS.
NEW CIRCUIT #1
NEW CIRCUIT #2
NEW CIRCUIT #3
NEW CIRCUIT #4
NEW CIRCUIT #5
REFER TO CIRCUIT DRAWINGS ON THIS PAGE FOR CONTINUATION AND DETAILS OF NEW CIRCUITS #1, #2, #3 AND #4
INSTALL 3" FLASH PORT IN MANIFOLD (THIS AREA) WITH PLUG BALL VALVE WHEN WORK IS COMPLETE

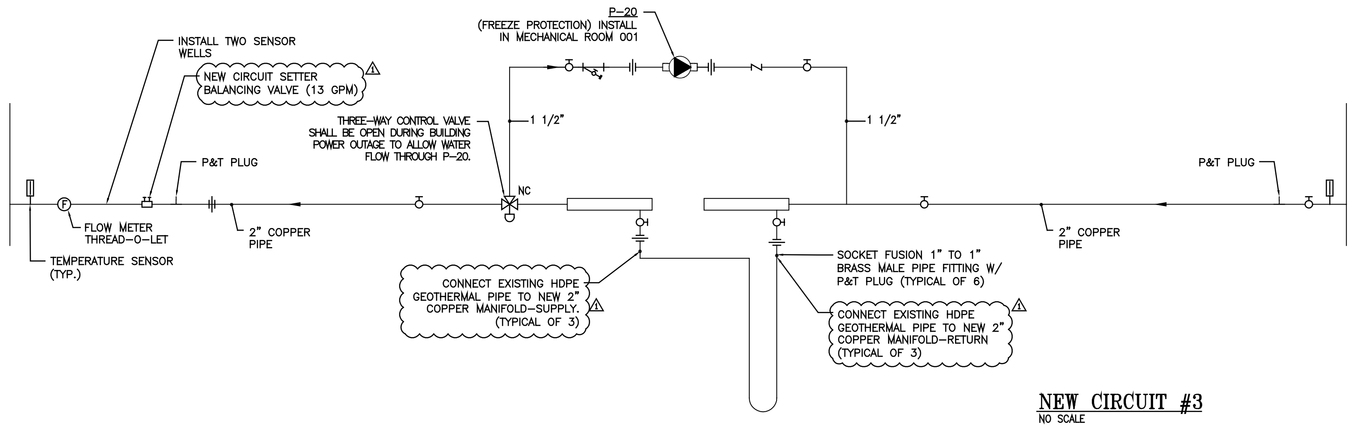
GROUND LOOP HEAT PUMP (GLHP) FLOW DIAGRAM
NO SCALE


P-18
(FREEZE PROTECTION) INSTALL IN MECHANICAL ROOM 001
INSTALL TWO SENSOR WELLS
NEW CIRCUIT SETTER BALANCING VALVE (54 GPM)
THREE-WAY CONTROL VALVE SHALL BE OPEN DURING BUILDING POWER OUTAGE TO ALLOW WATER FLOW THROUGH P-18.
1 1/2"
P&T PLUG
FLOW METER THREAD-O-LET
TEMPERATURE SENSOR (TYP.)
3" COPPER PIPE
NC
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 3" COPPER MANIFOLD-SUPPLY. (TYPICAL OF 13)
SOCKET FUSION 1" TO 1" BRASS MALE PIPE FITTING W/ P&T PLUG (TYPICAL OF 26)
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 3" COPPER MANIFOLD-RETURN (TYPICAL OF 13)

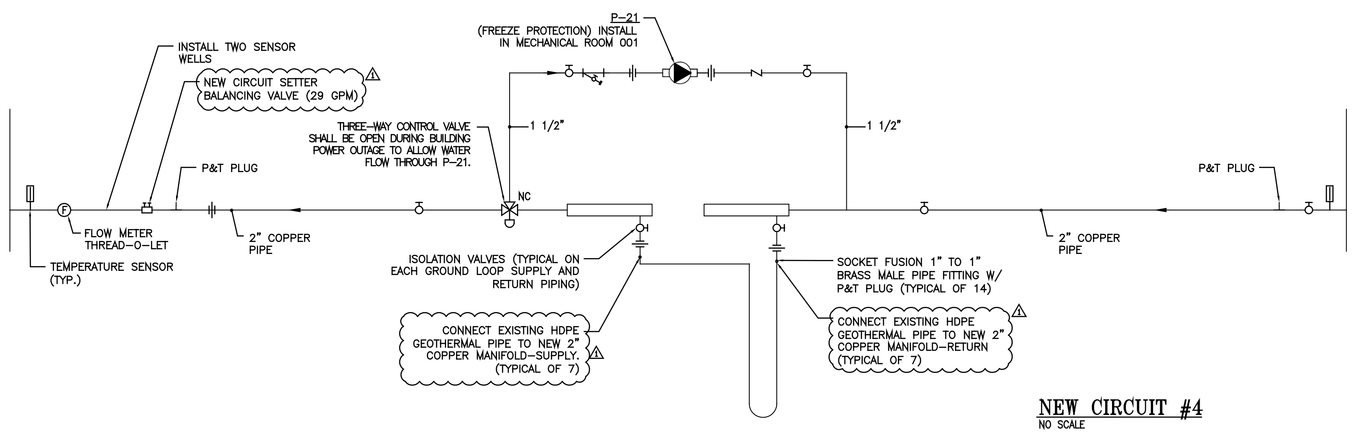
NEW CIRCUIT #1
NO SCALE


P-19
(FREEZE PROTECTION) INSTALL IN MECHANICAL ROOM 001
INSTALL TWO SENSOR WELLS
NEW CIRCUIT SETTER BALANCING VALVE (17 GPM)
THREE-WAY CONTROL VALVE SHALL BE OPEN DURING BUILDING POWER OUTAGE TO ALLOW WATER FLOW THROUGH P-19.
1 1/2"
P&T PLUG
FLOW METER THREAD-O-LET
TEMPERATURE SENSOR (TYP.)
2" COPPER PIPE
NC
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 2" COPPER MANIFOLD-SUPPLY. (TYPICAL OF 4)
SOCKET FUSION 1" TO 1" BRASS MALE PIPE FITTING W/ P&T PLUG (TYPICAL OF 8)
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 2" COPPER MANIFOLD-RETURN (TYPICAL OF 4)

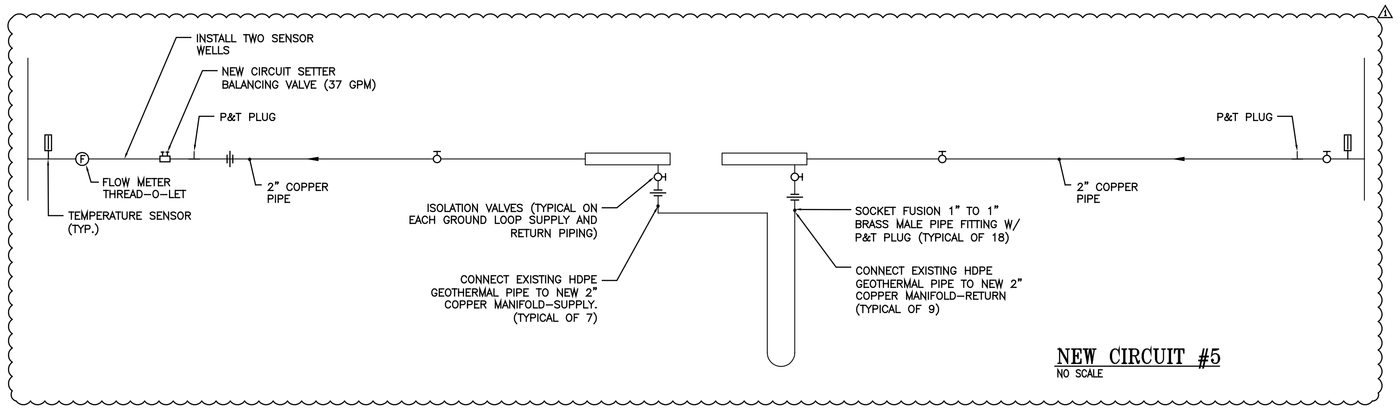
NEW CIRCUIT #2
NO SCALE


P-20
(FREEZE PROTECTION) INSTALL IN MECHANICAL ROOM 001
INSTALL TWO SENSOR WELLS
NEW CIRCUIT SETTER BALANCING VALVE (13 GPM)
THREE-WAY CONTROL VALVE SHALL BE OPEN DURING BUILDING POWER OUTAGE TO ALLOW WATER FLOW THROUGH P-20.
1 1/2"
P&T PLUG
FLOW METER THREAD-O-LET
TEMPERATURE SENSOR (TYP.)
2" COPPER PIPE
NC
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 2" COPPER MANIFOLD-SUPPLY. (TYPICAL OF 3)
SOCKET FUSION 1" TO 1" BRASS MALE PIPE FITTING W/ P&T PLUG (TYPICAL OF 6)
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 2" COPPER MANIFOLD-RETURN (TYPICAL OF 3)

NEW CIRCUIT #3
NO SCALE


P-21
(FREEZE PROTECTION) INSTALL IN MECHANICAL ROOM 001
INSTALL TWO SENSOR WELLS
NEW CIRCUIT SETTER BALANCING VALVE (29 GPM)
THREE-WAY CONTROL VALVE SHALL BE OPEN DURING BUILDING POWER OUTAGE TO ALLOW WATER FLOW THROUGH P-21.
1 1/2"
P&T PLUG
FLOW METER THREAD-O-LET
TEMPERATURE SENSOR (TYP.)
2" COPPER PIPE
NC
ISOLATION VALVES (TYPICAL ON EACH GROUND LOOP SUPPLY AND RETURN PIPING)
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 2" COPPER MANIFOLD-SUPPLY. (TYPICAL OF 7)
SOCKET FUSION 1" TO 1" BRASS MALE PIPE FITTING W/ P&T PLUG (TYPICAL OF 14)
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 2" COPPER MANIFOLD-RETURN (TYPICAL OF 7)

NEW CIRCUIT #4
NO SCALE


INSTALL TWO SENSOR WELLS
NEW CIRCUIT SETTER BALANCING VALVE (37 GPM)
P&T PLUG
FLOW METER THREAD-O-LET
TEMPERATURE SENSOR (TYP.)
2" COPPER PIPE
ISOLATION VALVES (TYPICAL ON EACH GROUND LOOP SUPPLY AND RETURN PIPING)
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 2" COPPER MANIFOLD-SUPPLY. (TYPICAL OF 7)
SOCKET FUSION 1" TO 1" BRASS MALE PIPE FITTING W/ P&T PLUG (TYPICAL OF 18)
CONNECT EXISTING HDPE GEOTHERMAL PIPE TO NEW 2" COPPER MANIFOLD-RETURN (TYPICAL OF 9)

NEW CIRCUIT #5
NO SCALE

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ISSUE: October 14, 2011

⚠	11/11/2011	ADDENDUM #2

SHEET TITLE:
MECHANICAL WATER FLOW DIAGRAMS

M5.1

SHW Project: 3111.003.00

ATTACHMENT “B”

FULL SPECIFICATION SECTIONS:

00420 BID FORM, 230923 DIRECT – DIGITAL CONTROL SYSTEM FOR HVAC, 230993 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS, 230010 - GENERAL CONDITIONS – MECHANICAL, 230519 – THERMOMETERS, 230520 - PRESSURE GAUGE, 230523 – VALVES, 230524 - HYDRONIC SPECIALTIES, 232113.33 - GEOTHERMAL SYSTEM, 235216 - CONDENSING BOILER, 236500 - COOLING TOWER, 237200 - ENERGY RECOVERY HEAT PUMP UNIT, 238146 - HEAT PUMP SYSTEM CLOSED CIRCUIT

SECTION 00420 - BID FORM

Bid For: TAYLOR ELEMENTARY SCHOOL HVAC RENOVATION PROJECT
ARLINGTON PUBLIC SCHOOLS, VIRGINIA

Submit: BY MAIL, HAND DELIVERY OR EXPRESS CARRIER TO:
Arlington Public Schools
Purchasing Department, 4th Floor
1426 N. Quincy Street, Arlington, VA 22207

Gentlemen:

1. The undersigned Bidder declares that he has informed himself fully of all conditions pertaining to the work and to the location where the work is to be performed; that he has examined the Bid Documents and Contract Documents, including the Agreement between Owner and Contractor, Conditions of the Contract (General and other conditions), Instructions to Bidders, the Drawings, the Specifications, all Addenda, and all conditions relative to the work to be performed.

2. The Bidder proposes and agrees, if this Bid is accepted within the number of days provided for in the PROJECT MANUAL, to enter into an Agreement with the OWNER in the form of contract specified, for the Contract Price, and within the Contract Time indicated in the Bid Documents to furnish all necessary material, equipment, machinery, apparatus, transportation and labor as required to complete the project indicated on this BID FORM.

3. The Bidder certifies that he has not combined, conspired or agreed to intentionally rig, alter or otherwise manipulate, or to cause to be rigged, altered or otherwise manipulated this Bid for the purpose of allocating purchases or sales to or among persons, raising or otherwise fixing the prices of the goods or services, or excluding other persons from dealing with Arlington Public Schools.

4. Arlington Public Schools requires that a minimum of 30 days after receipt of an approved Application for Payment (invoice) be allowed for payment.

5. The Bidder certifies that it will comply with all provisions of the Virginia Public Procurement Act and with the regulations of Arlington Public Schools.

6. By submitting a Bid, the Bidder represents that the Bidder understands the Insurance Requirements of these specifications and will comply in full if awarded the contract.

7. In submitting this Bid, Bidder represents, as more fully set forth elsewhere in the Bid and Contract Documents:

    a. Owner has recommended the Bidder examine the site and locality where the Work is to be, the legal requirements (federal, state, and local laws, ordinances, rules and regulations) and the conditions affecting cost, progress of performance of the Work and has made such independent investigations as Bidder deems necessary.

b. Bidder acknowledges that Owner and Owner's Representative (Architect) do not assume responsibility for the accuracy of dimensions or completeness of information and data shown or indicated in the Bid Documents with respect to existing facilities.

c. Bidder has given Owner's Representative (Architect) written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bid and Contract Documents and the

d. Written resolution thereof by Owner's Representative (Architect) is acceptable to Bidder, and the

Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work for which this Bid is submitted.

d. By bidding in response to this invitation, the Bidder represents that in the preparation and submission of this Bid, said Bidder did not, either directly or indirectly, enter into any combination or arrangement with any person, firm, or corporation or enter into any agreement, participate in any, collusion, or otherwise take any action in the restraint of free, competitive bidding in violation of the Sherman Act (15 U.S.C. Section 1) or Sections 59.1-9.1 through 59.1-9.17 or Sections 59.1-68.6 through 59.1-68.8 of the Code of Virginia.

e. Bidder hereby certifies that, if awarded the Contract for construction of the Project, it will take all possible actions to minimize costs to Owner that are related to any disruptions in any part of the Work resulting from unforeseeable conditions which may be encountered and Work changes or additions which may be made.

f. Bidder understands that the award of contract, if any, will be made on the basis of the Total Bid Amount, unless specifically stated otherwise. Bidder understands that upon award of Contract, all items specified in the Bid Documents shall be furnished unless an "Or-Equal" or "Substitute Item" is accepted by Owner in accordance with paragraph 10, Substitutions, Section 10, Instructions to Bidders. .

g. The Bidder agrees to bear full cost of maintaining the Work until final acceptance of the Work is approved as provided by the Contract.

h. This Bid will remain subject to acceptance for sixty (60) days after the day of the Bid opening.

i. Owner may cancel this Invitation to Bid, and to reject any and all Bids received.

8. Bidder agrees to the requirements for substantial completion, final completion, and liquidated damages as follows:

a. The Work will be commenced in accordance with the Contract Documents and will have the following milestone dates;

1. All long lead mechanical equipment orders confirmed – February 15th 2012

2. Contractor Access to on-site exterior staging and storage area – March 1st 2012;
3. Begin work in boiler/mechanical room and steam tunnels – March 30th 2012;
4. Total building available for construction work – June 25th 2012;
5. Building Substantial Completion – August 13th 2012;
6. Final Completion of the project – August 31st, 2012.

These dates are subject to adjustments of this Contract Period as provided in the Contract Documents.

b. Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), the Contractor shall pay Owner $1,000.00 for each day that expires after the time specified in Paragraph 5 of the Agreement between Owner and Contractor (Section 00400) for substantial completion, plus any approved time extensions, until all of the Work is substantially complete, and Contractor shall pay Owner $1,000.00 for each day that expires after the time specified in Paragraph 5 of the Agreement between Owner and Contractor (Section 0400) for final completion, plus any approved proper time extensions, until all of the Work is finally complete.

9. The following documents are attached to and made part of this Bid:

a. Required Bid Security in the form of either a certified check, cash escrow or Bid Bond in the amount of five percent of the Bid amount.

b. List of Subcontractors as required in Instructions to Bidders.

10. By submitting this Bid, the Bidder certifies that the firm submitting this Bid and registered under that name has the appropriate license and/or certification, as determined by the Commonwealth of Virginia, Department of Professional and Occupational Regulation, Virginia Board for Contractors to perform the scope of work included in this Bid. Include license number below:

Registered as a Contractor under Title 54.1, Chapter 11 of the Code of Virginia:

Licensed Class _____ Virginia Contractor No. _____ Valid until

_____ (Date).

Classifications _____

11. Bidder has examined copies of all the Contract Documents and of the following addenda, and receipt of all is hereby acknowledged:

Addendum No. ___ Dated: _____ Addendum No. ____ Dated: _____

Addendum No. ___ Dated: _____ Addendum No. ____ Dated: _____

Addendum No. ___ Dated: _____ Addendum No. ____ Dated: _____

12. ANY NOTATION ON THE EXTERIOR OF THE ENVELOPE PURPORTING TO ALTER, AMEND, MODIFY OR REVISE THE BID CONTAINED WITHIN THE ENVELOPE SHALL BE OF NO EFFECT AND SHALL BE DISREGARDED.

13. BID SCHEDULE

My Bid to provide all labor, materials and equipment necessary to complete the work described in this Invitation to Bid is provided in this Bid Schedule.

BID ITEM 1. TOTAL BASE BID:

_____ In Writing $_____ In Figures

BID ITEM 2. PRICING BREAKDOWN FOR TOTAL BASE BID ABOVE:

Provide Lump Sum prices per Division as listed in the Project Manual Table of Contents:

A.	Division 1:	_____	Dollars ($_____)
B.	Division 2:	_____	Dollars ($_____)
C.	Division 4:	_____	Dollars ($_____)
D.	Division 5:	_____	Dollars ($_____)
E.	Division 7:	_____	Dollars ($_____)
F.	Division 9:	_____	Dollars ($_____)
G.	Division 23:	_____	Dollars ($_____)
H.	Division 26:	_____	Dollars ($_____)
I.	Total must equal base bid.		Dollars ($_____)

BID ITEM 3. ADDITIVE BID ITEMS

The undersigned proposed to modify the BASE BID as stated below. The amounts to be added to the BASE BID reflect any modifications of work that the undersigned may be required to perform by reason of acceptance of the Alternate Bid Item. Alternate Bid Items may or may not be accepted.

ALTERNATE BID ITEM NO 1:

Following removal and disposal of the classroom heat pump units (included in the Base Bid), the work of Alternate No. 1 includes: Removal of all supply and return piping between the points of entry into the crawl space and the disconnected classroom heat pump unit; pressure testing each of thirteen (13) wells in accordance with Specification Section 232113.33; identification of functioning/non-functioning wells; capping of all geothermal piping after pressure testing, and cleaning of the work area. State the amount to be added to the Base Bid to provide all work described above.

ADD _____ Dollars ($_____.00)

ALTERNATE BID ITEM NO 2:

Following removal and disposal of the classroom heat pump units (included in the Base Bid), the work of Alternate No. 2 includes: Removal of all supply and return piping between the points of entry into the crawl space and the disconnected classroom heat pump unit; pressure testing each of four (4) wells in accordance with Specification Section 232113.33; identification of functioning/non-functioning wells; capping of all geothermal piping after pressure testing, and cleaning of the work area. State the amount to be added to the Base Bid to provide all work described above.

ADD _____ Dollars ($_____.00)

ALTERNATE BID ITEM NO 3:

Following removal and disposal of the classroom heat pump units (included in the Base Bid), the work of Alternate No. 3 includes: Removal of all supply and return piping between the points of entry into the crawl space and the disconnected classroom heat pump unit; pressure testing each of three (3) wells in accordance with Specification Section 232113.33; identification of functioning/non-functioning wells; capping of all geothermal piping after pressure testing, and cleaning of the work area. State the amount to be added to the Base Bid to provide all work described above.

ADD _____ Dollars ($_____.00)

ALTERNATE BID ITEM NO 4:

Following removal and disposal of the classroom heat pump units (included in the Base Bid), the work of Alternate No. 4 includes: Removal of all supply and return piping between the points of entry into the crawl space and the disconnected classroom heat pump unit; pressure testing each of seven (7) wells in accordance with Specification Section 232113.33; identification of functioning/non-functioning wells; capping of all geothermal piping after pressure testing, and cleaning of the work area. State the amount to be added to the Base Bid to provide all work described above.

ADD _____ Dollars ($_____.00)

ALTERNATE BID ITEM NO 5:

Following removal and disposal of the classroom heat pump units (included in the Base Bid), the work of Alternate No. 5 includes: Removal of all supply and return piping between the points of entry into the classroom and the disconnected classroom heat pump unit; pressure testing each of nine (9) wells in accordance with Specification Section 232113.33; identification of functioning/non-functioning wells; capping of all geothermal piping after pressure testing, and cleaning of the work area. State the amount to be added to the Base Bid to provide all work described above.

ADD _____ Dollars ($_____.00)

BID ITEM 4. UNIT PRICES

The bidder is required to supply unit costs for the work in the Alternate Bid Items. Prices given shall apply to the deductions or additions to the work and shall include the item installation costs. Failure to quote unit prices may result in the rejection of the bid. The Owner reserves the right to delete unit prices from the executed contract that are deemed unreasonable.

UNIT PRICE NO. 1: CIRCUIT #1 – 4 (ALTERNATE BID ITEMS #1-4)

Provide all materials and labor required to connect existing geothermal piping in crawl space (capped off and identified by scope of work required by Alternate Bid) to new supply and return manifold in the boiler room. Work includes, but is not limited to, piping, valves, hangers, fittings, insulation and pumps. Refer Mechanical Drawings and Specification for details. This unit price shall apply to each functional geothermal well in Circuits #1-4 that is to be connected to the new manifold.

_____/cy

UNIT PRICE NO. 2: CIRCUIT #5 (ALTERNATE BID ITEM #5)

Provide all materials and labor required to connect existing geothermal piping above ceiling (capped off and identified by scope of work required by Alternate Bid) to new supply and return manifold in the boiler room. Work includes, but is not limited to, piping, valves, hangers, fittings, insulation and pumps. Refer Mechanical Drawings and Specification for details. This unit price shall apply to each functional geothermal well that is to be connected to the new manifold. This unit price shall apply to each functional geothermal well in Circuit #5 that is to be connected to the new manifold.

_____/cy

AWARD OF BID: Award will be based on the Total Base Bid amount entered on the BID FORM.

My signature certifies that this firm or individual has no business or personal relationships with any other companies or persons that could be considered as a conflict of interest or potential conflict of interest to Arlington Public Schools, and that there are no principals, officers, agents, employees, or representatives of this firm that have any business or personal relationships with any other companies or person that could be considered as a conflict of interest or a potential conflict of interest to Arlington Public Schools, pertaining to any and all work or services to be performed as a result of this request and any resulting contract with Arlington Public Schools.

By:_____

Name:_____

Title:_____

Date:_____

14. CONTACT FOR ADMINISTRATION:

NAME: _____

ADDRESS: (Office) _____

_____

TELEPHONE NUMBER: (Office) _____ FAX NUMBER: _____

_____

FULL LEGAL NAME OF BIDDER _____

Remittance Address (If different):

ADDRESS_____ _____

_____ _____

_____ _____

PHONE: (__)_____ FAX: (_____) DATE:_____

TAX ID NUMBER (EIN/SSN):_____

EMAIL ADDRESS:_____

15. STATE CORPORATION COMMISSION (SCC) IDENTIFICATION NUMBER:

Under paragraph 1, Contractor Registration, of Section 00111, Instruction to Bidders, the Bidder agrees, if this Bid is accepted by Arlington Public Schools, for such services and/or items, that the Bidder has met the requirements of the Virginia Code Section 2.2-4311.2.

Please complete the following by checking the appropriate line that applies and providing the requested information:

1. Bidder is a Virginia business entity organized and authorized to transact business in Virginia by the SCC. The bidder's identification number issued by the SCC is _____. *(The SCC number is NOT your federal tax Identification number)*.

2. Bidder is an out-of-state (foreign) business entity that is authorized to transact business in Virginia by the SCC and such bidder's identification number issued to it by the SCC is _____.

3. Bidder does not have and identification issued to it by the SCC and such bidder is not required to be authorized to transact business in Virginia by the SCC for the

following reason(s):

_____

_____

Please attach additional sheets if you need to explain in further detail why such bidder is not required to be authorized to transact business in Virginia.

16. LIST OF SUBCONTRACTORS:

The Bidder submits the following names of Subcontractors to be used in performing the Work for Invitation to Bid with which this form is submitted. The Bidder is responsible for listing any Subcontractors not identified below,

The Bidder certifies that all Subcontractors listed are eligible to perform the Work, and that all Subcontractors performing more than five percent of the Work are listed.

Subcontractor's Work	Subcontractors Name
Acoustic Ceilings:	_____
Mechanical:	_____
Electrical:	_____

(This form should be submitted with the Bid).

END OF SECTION 00420

SECTION 230010

GENERAL CONDITIONS - MECHANICAL

PART 1 - GENERAL

1.01 DESCRIPTION AND SCOPE

A. These specification is applicable to and a part of Division 23, Mechanical Specifications.

B. Division of the specification into divisions and sections is for the purpose of simplification alone. Responsibility for the work of various trades shall rest with the Contractor.

C. The specifications and drawings establish the quality of materials, equipment, workmanship and methods of construction. The Contract Documents are intended to secure for the Owner first class installation in every respect.

D. The work included under Division 23 of the specifications shall include complete mechanical systems as shown on the drawings and as specified herein. Provide all supervision, labor, material, equipment, machinery, and other items necessary to complete the mechanical system. Labor shall be performed by skilled mechanics and the entire plant, when delivered to the Owner, shall be ready for satisfactory and efficient operation.

E. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

F. Contractor shall coordinate all work in the building in order to facilitate the intelligent execution of the work.

G. Contractor shall assistance to the commissioning personal, as needed, and as required by the commissioning specification.

H. . The following are approved by the owner the control system suppliers, manufacturers, and product lines:

Supplier	Manufacturer	Product Line
Automated Logic - Virginia	Automated Logic Corporation	WebCTRL

The mechanical, electrical contractors and the commissioning agent shall thoroughly coordinate their respective disciplines work with Automated Logic, see specification sections 230900 and 230993. The owner will have a separate from this contract with Automated Logic. The contractor should reference Spec Section 00700, Part 7.

1.02 CONTRACT DOCUMENTS

A. The drawings and specifications cover the extent and general arrangement of the various systems, subject to the individual characteristics of the mechanical equipment with the regard to size and arrangement. The mechanical and electrical drawings shall be considered as being diagrammatic. The attention of the Contractor is called to the fact that while these drawings are generally to scale and are made as accurately as the scale will permit, all important dimensions shall be determined in the field. They are not to be considered as erection or shop drawings. They do not indicate every fitting, elbow, offset, valve, pullbox, etc., which is to complete the job. Contractor shall prepare field erection drawings as required for the use of his mechanics to insure proper installation.

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B. Interference between trades must be determined before the work is fabricated or installed. The Contractor must coordinate the work during the preliminary stages to insure that actual erection will proceed without such interferences. Such coordination is of paramount importance and no request for additional payment will be considered where such request is based upon interferences between trades.

C. Contractor shall carefully examine the Contract Documents and bring to the Owner attention any discrepancies.

1.03 SITE EXAMINATIONS

A. All bidders, prior to submitting a bid, shall visit the site and thoroughly acquaint themselves with the conditions under which the work will be performed. Particular attention shall be given to existing conditions.

B. Examine all services, equipment, surfaces, etc., which this is in any way dependent upon and report to the Architect any condition which will result in less than a first class installation.

C. Connections to existing work are shown diagrammatically. These conditions shall be made as required by existing conditions.

D. Waiver of responsibility or requests for additional payment based on lack of knowledge of conditions at the site will not be acceptable or considered.

1.04 REFERENCES AND DEFINITIONS

A. References to catalogs, standards, codes, specifications and recommendations, etc., means latest edition of such publications in effect at date of invitation to submit proposal.

"Engineer"	-	means the SAS.
"Directed"	-	means "directed by Owner".
"Provide"	-	means "furnish and install".
"Indicated"	-	means "indicated in contract drawings".
"Concealed"	-	means items referred to are hidden from normal sight. This includes items in partly excavated or crawl spaces and in service tunnels used solely for repairs and maintenance.
"Exposed"	-	means items are not "concealed".

B. Where any device or piece of equipment is referred to in the singular number, such reference shall be deemed to apply to as many devices as are required to complete the installation.

1.05 CODES, RULES AND PERMITS

A. Installation shall be made in compliance with all applicable state and local codes and regulations, N.E.C., and NFPA requirements and utility company rules, all of which shall be considered a part of this specification and shall take precedence in the order of listing.

B. Unless otherwise directed, all connection fees to public utilities will be paid by the Contractor. The Contractor shall obtain all required Certificates of Inspection for his work and deliver same to the Owner before request for acceptance and final payment for his work.

C. Contractor shall pay for all cost of connections to and running from local utility lines, whether the work is performed by this Contractor, Utility Company or Government Agency.

1.06 PROTECTION OF WORK AND MATERIALS

A. Contractor shall be responsible for the proper care and protection of all portions of all materials delivered and work performed by him until completion and acceptance of the work as a whole.

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Payment made on account of the contract shall in no way relieve the Contractor from this responsibility.

B. Contractor shall cap all pipes, ducts, etc., (not completed) until ready for final inspection, after which they shall be thoroughly cleaned and left unobstructed in any way. Cap with like material, i.e. galvanized steel, copper, etc.

C. If during the progress of the work, any portion thereof shall be liable to damage from inclement weather or other work, such effective protection as may be deemed necessary by the Owner must be provided by this Contractor.

D. All work which does not comply with the requirements of the Contract, or all work damaged by reason of neglect on the part of the Contractor, or lack of protection prior to acceptance, shall be removed.

E. Contractor shall be responsible for damage caused by leaks in any of the equipment or material installed by him through equipment or material failures or disconnected pipes or fittings, and shall make, at his own expense, all repairs or replacements required as a result of such damage.

1.07 TEMPORARY SERVICE

A. Unless specifically called for, and outlined under the individual section of the specifications, all temporary services required for building construction including water, heat, air conditioning, ventilation, electricity, sanitary facilities, etc., will be furnished by the General Contractor. The general contractor will provide heat to maintain the building above freezing throughout the construction period.

1.08 GUARANTEE

A. The Contractor shall guarantee that all work performed and all materials and equipment installed by him are free from defects. He shall repair or replace any defective equipment, materials, or workmanship, free of cost to the Owner for a period of two (2) years from date of acceptance, upon notice from the Architect.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

A. The materials or products specified herein and/or indicated on the drawings by trade names, manufacturer's names or catalog numbers establish the quality of materials or products to be furnished and shall be the basis of each bid. Contracts will be awarded on that basis. Substitutions may be permitted in accordance with Division 1 requirements.

2.02 STANDARDS FOR MATERIALS AND EQUIPMENT

A. Materials and equipment shall be new, unless specifically exempt.

B. Like materials or equipment shall be the product of one manufacturer.

C. Materials and equipment furnished under this specification shall be the standard products of manufacturers regularly engaged in the production of such materials and equipment and shall be the manufacturer's latest standard design.

D. Where Underwriters' Laboratories, Inc., Standards are recommended or required, all materials and equipment shall be approved by them and shall bear the U.L. label.

E. Third Party Certification: All packaged equipment shall be independently Third Party as a system for it's intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with

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OSHA Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70, National Electric Code (NEC), Article 90.7.

F. All adhesives, sealants and welding solvents shall have no more than the following VOC content:

1. PVC Welding: 510 g/L
2. CPVC Welding: 490 g/L
3. ABS Welding: 325 g/L
4. Plastic Cement Welding: 250 g/L
5. Adhesive Primer for Plastic: 550 g/L
6. All Other Welding & Installation Adhesives & Sealants: 250 g/L

2.03 MECHANICAL SUBMITTALS, SHOP DRAWINGS AND SAMPLES

A. Submit in accordance with the General Conditions of the contract and the additional stipulations and format set forth herein.

B. Where one or more products are named in the specifications and the phrases "or equal", "approved equal", or their equivalent, accompanies the listing, requests for approval of substitute products will be considered after award of contract only. Requests shall be made in writing including all information, such as, delivery dates and descriptive data, and all samples required by the Owner, together with the amount to be added to or deducted from the contract price for such substitution. Decisions of the Owner as to whether a product proposed for substitution is fully equal will be final and not subject to arbitration. Where products are named in the specification but are unaccompanied by the phrases "or equal", "or approved equal", or their equivalent, applications for approval of substitute products will not be considered at any time.

C. When any specified item or "approved equal" item of equipment or material is submitted which required changes or additions to the designed structures, finish or Plumbing, Heating, Ventilating and/or Electrical services because its requirements exceed or are different from those shown on the Contract Documents, such changes shall be made at no additional cost to the Owner, and shall be itemized in writing and attached to the submittal. No changes shall be made without approval in writing from the Owner. The requirements of this paragraph apply also when no manufacturer is named and when more than one manufacturer is listed as acceptable.

D. Coordinated shop drawings drawn to a scale of 2 inch to the foot shall be submitted for approval.

The mechanical contractor shall have employed or available for his use persons skilled in producing shop drawings/coordination drawings and that are capable of producing these in a timely fashion so as not to impede progress or cause delay in execution of the work.

The coordinated shop drawings shall coordinate and show architectural features, structural features, all duct work, lighting fixtures, piping, electrical conduits, mechanical equipment, HVAC equipment, plumbing equipment and fixtures and electrical equipment.

The mechanical contractor will coordinate these drawings with all other trades.

E. Submit complete plan and section views with the above coordinated drawings.

F. Forward shop drawings in single copy sepia or other equivalent transparency and one blue-line print. Notations as to acceptance or correction will be noted on transparency. Upon return of transparency, the Contractor shall correct the original tracing and submit a new transparency for review. Upon final acceptance of the transparency, prepare prints for the use of the various trades as may be required.

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G. Submit complete wiring diagrams for all equipment furnishes under Division 23, for the use of the electrical trades, showing all equipment and control device terminals and the relationship to the electrical service.

H. Furnish samples of materials when requested by the Owner prior to acceptance of submittals.

I. Submittal stamping: The intent of the submittals is to help the Contractor avoid mistakes in the purchase of equipment, to advise him of the related equipment that might be affected by substitution and to help avoid purchases of equipment that is not equal to the specified equipment: Approved by the Owner or Engineer does not modify the requirements of the Contract Documents. Deviations from these requirements must be specifically requested and approval received in writing from the Owner or Engineer before such deviation will be permitted. The "Approval" stamp does not constitute such written approval.

J. Shop drawings or submittals stamped "Approved as Corrected" give authority to proceed in accordance with the notes. However, final shop drawings bearing all corrections noted shall be resubmitted prior to receipt of that item on the job site.

K. Submit all adhesives, sealants and welding solvents used on site for review and approval.

2.04 ACCESS PANELS

A. Panels to be Higgins Products Co., Milcor Steel Co., Karp Assoc., Inc., Walsh Spencer Co., Wilkinson Co., or Zurn Industries, Inc., and shall be set in frames with counter sunk screws and shall have cylinder locks. All locks shall have one master key.

PART 3 - EXECUTION

3.01 GENERAL CONSTRUCTION REQUIREMENTS

A. Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels.

B. Make provisions for easy access to valves, strainers, panels, motors, drives, dampers, filters, controls devices, and similar items requiring inspection or maintenance.

C. All appliances and equipment shall be installed and connected in accordance with the best engineering practice. Manufacturer's instructions and recommendations shall be followed and all auxiliary piping, water seals, valves, electric connections, etc., shall be provided.

D. All piping, ducts and conduits shall be run parallel with the lines of the building, except as otherwise indicated.

E. Provide approved shields to prevent the contact of dissimilar metals. The shield shall provide a separation so that the electrical current is below one percent of the current which would exist with metal-to-metal contact.

3.02 EXCAVATION AND BACKFILL

A. Trenches for Piping underground and under floor slabs shall be excavated to a uniform grade. Holes shall be provided for hub and spigot piping so that each length of pipe shall have a solid bearing for the full length of the barrel.

B. Organic materials, leaf mold, debris, mud and other unstable material shall be removed to a depth sufficient to allow the construction of a stable foundation. All cuts below the required trench grade will be refilled with compacted sand or fine gravel to insure a stable base for the piping.

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C. Trenches shall be braced and sheathed. Water shall be removed as necessary to protect workmen and adjacent structures. No pipe or masonry shall be laid under water.

D. After piping has been tested and approved, the trenches shall be backfilled by compacting each lift, by whatever means necessary, to assure the following percentages of maximum dry density:

Underlying lifts - 95%
Top 12 inches - 95%

E. Backfill shall be compacted mechanically in layers not exceeding 6 inches deep. Backfill shall be placed and sheathing removed in such a manner that pipes will not be disturbed.

F. The Contractor shall provide barricades around all open trenches.

G. The Contractor shall confirm to invert grades shown on the drawings and shall verify the location of mains as indicated before trench excavation is started.

3.03 UTILITY CONNECTIONS

A. Ascertain from the utility department or utility company the exact amount of work required in connection of utilities. Work required which is not provided by the utility department or company shall be provided by the Contractor, unless indicated otherwise.

B. Verify the location and depth of all utilities and call to the attention of the Owner any discrepancies, which involve additional work before signing of the contract.

C. After the contract is signed, any additional work required for the complete and working job shall be provided at no additional cost to the Owner, unless indicated otherwise.

D. Locations, depths, sizes, capacities, etc., of utility lines shall be verified by the Contractor prior to doing any other work on piping systems which are to connect to such utility lines. Any work rendered unusable by failure to comply with this provision shall be replaced at no cost.

E. Utilities as mentioned in this division of the specifications shall include water, sewers, gas, and other piping systems necessary to the operation of any new or existing systems and equipment.

3.04 NOISE AND VIBRATION

A. Mechanical equipment and devices shall operate without objectionable noise and vibration being transmitted to occupied portions of the building or any part of the building structure by apparatus, piping, ductwork, conduits, or other parts of the mechanical work. Secure and brace all piping and ductwork, provide flexible connections, vibration isolators, or other devices where indicated or required to prevent the transmission of noise and vibration to the building.

B. Air distribution devices, air moving units, light fixture air diffusers, fans, thermostats and other such equipment that may produce sound or vibration either outside or within the occupied space of the building shall, as a minimum requirement, conform to the installation details and recommendations in the ASHRAE Handbook Applications.

3.05 ACCESS PANELS

A. Provide metal access panels at all points where valves, traps, cleanouts, etc., are concealed in walls, floors, or ceilings. Metal access panels shall be labeled with the same fire protection rating as the wall, floor or ceiling in which it is being installed.

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3.06 CLEARANCES

A. Check layout of systems with the Architectural drawings and verify all dimensions and conditions at the project site. No extra compensation will be allowed because of differences between actual dimensions and spaces and sizes indicated on the drawings.

B. All work shall be neatly installed so as to be readily accessible for operation, maintenance, and repair, without the reduction of necessary headroom and passage clearance.

C. Dimensions or equipment shall permit the entrance into space allotted to it, and shall permit ready access to it and adjoining equipment for maintenance and repair. Equipment, which does not fit into its allowed spaces with sufficient clearance for proper maintenance, will be rejected as unsuitable. Contractor shall check equipment for major differences in size which shall be indicated on the submission to avoid inaccessible locations.

3.07 RUBBISH

A. All rubbish and other debris due to or connected with work performed under this division of the Contract shall not be allowed to accumulate and shall be hauled from the premises to provide a clean work site.

B. All trades shall at the end of each work day leave the area broom clean and all materials stored in an orderly fashion.

3.08 MANUALS

A. Contractors shall furnish three (3) manuals in loose-leaf binders.

B. The names of the Project, Owner, and Discipline, "Heating, Ventilation and Air Conditioning, or Plumbing, Electrical, etc....," will be glued in the front of each manual.

C. An index will be included with Section tabs for each subject included.

D. Manuals will be submitted for approval.

E. The manuals shall include as a minimum the following for all equipment and systems installed.

1. Complete and correct manufacturer's shop drawings and submittal data. All model numbers, equipment capacities and characteristics will be clearly indicated. Each piece of equipment will be identified the same as identified on the contract drawings and its location shall be indexed to a key plan.
2. Manufacturer's installation manual, Service manual, and parts list.
3. Start-up and shutdown instructions for all major seasonal changeover instructions.
4. Trouble shooting instructions.
5. Valve charts and electric motor schedules.
6. Lubrication time schedule for all equipment with schedule of lubricants to be used.
7. Belt sizes, types, lengths, and belt number.
8. Description of each system installed and operating instructions.
9. "As installed" control diagrams and description of sequence of operation by the Control Manufacturer.
10. Complete "as installed" color coded wiring diagrams of refrigeration system and all electrical connections of other mechanical equipment.
11. Copies of pipe, ductwork, and equipment identification charts.
12. Manufacturer's guarantees or warranties.

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13. Name, Address, and Telephone Number of local or nearest Manufacturer's Representative.
14. Name, Address, and Telephone Number of firm or persons to perform service work during guarantee and warranty period.

3.09 OPERATING INSTRUCTIONS

A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in the operation, adjustment and maintenance of all products, equipment and systems. Instruction time shall be sufficient to fully instruct all shifts of the Owner's operating and maintenance personnel.

B. Operations and maintenance manual shall constitute the basis of instruction. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

3.10 COMPLETION REQUIREMENTS

A. Before acceptance and final payment, the Contractor shall provide the following:

B. The mechanical contractor shall maintain at the site for the owner, one (1) copy of all drawings showing in red ink all changes from the original plans made during installation of the work, specifications, addenda, approved shop drawings, change orders and other modification. This set shall remain in the office at all times and shall not be used for the construction references. These As-Built drawings shall be delivered to the owner upon completion of the work in a reproducible and electronic format. An additional set shall be given to the engineer for his records.

C. Three bound manuals.

D. All required testing and balancing reports.

E. Framed, under glass, complete diagrams of operating instructions for air conditioning and heating controls, including new and existing equipment.

F. Framed, under glass, complete valve charts.

G. Electric Motor Schedule: Before final inspection of the project, submit a schedule listing each motor connected, regardless of under which division of these specifications the motor was furnished. Include the following information for each motor:

Location room number, area, etc.

Description of motor duty. Air unit fan motor, refrigeration compressor motor, geothermal water pump motor, for examples.

Type of coupling. Direct drive, V-belt, flexible coupling, etc., belt specification.

Motor manufacturer's name and serial number of motor.
Motor rated horsepower.
Motor speed, rpm.
Motor nameplate ratings, voltage, number of phases, temperature rise.
Nameplate amperage at connected voltage.
Starter and heater manufacturer, size and rating.
Type of motor bearing type and lubrication instructions.
Catalog information for starters as follows:
Manufacturer's name and catalog number.

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Rating.

Manuals as described in these specifications mean binders filled with all required information. Copies of submittal alone will not be accepted nor will generic manufacturer's maintenance manuals. Generic maintenance manuals must be altered to show specific data concerning models of equipment installed at this project, along with equipment designation shown on the contract drawings.

H. Cleanup Requirements:

1. Refer to Architectural specification.
2. Clean equipment and restore to new condition.
3. Touch up paint finish damage.
4. When paint damage is extensive, as determined by the Engineer, repaint completely with paint equal to original finish.
5. Exposed metal that is not painted, that has rusted shall be brushed down with steel brush to remove rust and other spots and left smooth and clean.

I. Upon completion of the entire work covered by this specification, a certificate of approval from the different departments having jurisdiction, shall be obtained and be delivered to the Owner. After the certificates have been received and final inspection of the work has been found satisfactory by the Owner, the Owner will issue to the Contractor a certificate of approval and acceptance. The certificate will in no way relieve this Contractor from the terms of his guarantee.

END OF SECTION

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SECTION 230519

THERMOMETERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide adjustable angle connection type thermometers as shown on the drawings, details and as specified.

B. Submit manufacturer's catalog data including scale range, ratings, and performance curve.

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Basis of design: Flo Lab Series L9VU.

B. Case: V" shape design, high pressure die cast aluminum, baked blue epoxy enamel finish. Heavy glass protected front firmly secured against rattles by spring action.

C. Stem: Steel tapered bulb chambers copper plated.

D. Locking Device: Two adjusting screws provide full 360o adjustment of thermometer case and stem.

E. Adjustable Joint: Die cast aluminum finished to match case. Completely encloses capillary to prevent tempering and foreign particles from entering instruments.

F. Tube & Capillary: Alcohol filled magnifying lens "Green Reading" tube.

G. Accuracy within 1% of full scale range. Silicone shock mounted for lasting durability. Range: 30 F to 180 F.

H. Scale: Satin faced non-reflective aluminum with bold jet black markings permanently etched. Locked in place and adjustable through device at top scale. No mounting screws to obliterate scale markings.

I. Socket: Provide brass socket.

J. Federal Spec: Units shall comply with Federal Specification GG-T-32ID.

K. Manufacturers: Flo Lab or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install thermometers in accordance with manufacturer's instructions. Coordinate with other work. Calibrate units to insure accurate readings.

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B. Install Thermometers on the supply and return geothermal circuits connected to the geothermal manifold in the mechanical Room (Boiler Room).

C. Install Thermometers on the condenser water piping and hot water piping, as shown on the flow diagram.

D. Coordinate with the control specifications sections 230900 and 230993.

END OF SECTION

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SECTION 230520

PRESSURE GAUGES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide gauges where indicated on the drawings and details in accordance with specifications.

B. Submit manufacturer's data including scale range, ratings, and performance curve.

PART 2 - PRODUCTS

2.01 PRESSURE, VACUUM AND COMBINATION GAUGES

A. Dial Size: 4-1/2".

B. Case: One piece phenolic turret type, with safety blowout disc.

C. Accuracy: 2 of 1% of full scale range.

D. Bourdon Tube: Phosphor bronze, brass socket, 3" connection with forged brass socket and tip and silver brazed joints.

E. Movement: Stainless steel rotary type with geared adjustable micrometer pointer.

F. Dial: White background, black lines and numerals.

G. Range: Select with normal operating pressure in the middle one third of scale.

H. Manufacturers:

1. Ashcroft: No. 1279A.
2. Trerice: No. 450SS.
3. Weiss: Series UG.
4. Weksler: No. AA1, Case P.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install gauges on steam lines with coil syphon and tee handle cock.

B. Install gauges on water lines with tee handle cock.

C. Install gauges on pump discharges with pulsation dampener and tee handle cock.

D. Coordinate with the control specifications sections 230900 and 230993.

END OF SECTION

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SECTION 230523

VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide valves as shown on the drawings and as specified herein.

B. Valves shall be provided in main piping systems at their source; in branches at mains and risers; in lines to equipment; in lines for proper servicing of accessories; and in lines to groups of two or more fixtures.

1.02 SUBMITTALS

A. Submit manufacturer's catalog data, performance specifications, and dimension data for each type and size of valve.

1.03 EXTENSION FOR INSULATION

A. Provide factory installed extensions on all valves so insulation can be properly installed.

PART 2 - PRODUCTS

2.01 VALVES GENERAL

A. Gate valves, screwed ends 2 inches and smaller, bronze, rising stem solid wedge disc, 125 psi SWP, 200 psi WOG, Crane 428, Jenkins 47, Nibco T-111, Stockham B-107.

B. Gate valves, flanged ends, 2-1/2 inches and larger, iron body, bronze mounted, non-rising stem, solid wedge disc, 125 psi SWP, 200 psi WOG, Crane 461, Jenkins 326, Nibco F-619, Stockham G-612.

C. Gate valves, solder ends, 2 inches and smaller, bronze, rising stem, solid wedge disc, 125 psi SWP, 200 psi WOG, Crane 1334, Jenkins 1242, Nibco S-111, Stockham B-109.

D. Globe valves, screwed ends, 2 inches and smaller, bronze, 150 psi SWP, 300 psi WOG, Crane 7 Jenkins 106-A, Nibco T-235, Stockham B-22. Furnish disc suitable for service intended.

E. Globe valves, flanged ends, 2-1/2 inches and larger, iron body;, bronze trim, 125 psi SWP, 200 psi WOG, Crane 351, Jenkins 613, Nibco F-718, Stockham G-512. Furnish disc suitable for service intended.

F. Globe valves, solder ends, 3 inches and smaller, bronze, 125 psi SWP, 200 psi WOG, Crane 1310, Jenkins 1200, Nibco S-211, Stockham B-14. Furnish disc suitable for service intended.

G. Swing check valves, screwed ends 2 inches and smaller, bronze 125 psi SWP, 200 psi WOG, Crane 34, Jenkins 92-A, Nibco T-413, Stockham B-319.

H. Swing check valves, flanged ends, 2 inches and larger, iron body, bronze mounted, 125 psi SWP, 200 psi WOG, Crane 373, Jenkins 624, Nibco F-918, Stockham G-931.

I. Swing check valves, solder ends, 2 inches and smaller, bronze 125 psi SWP, 200 psi WOG, Crane 1303, Jenkins 1222, Nibco S-413, Stockham B-309.

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J. Non-slamming check valves: Smolensky noiseless, Williams-Hager, Mueller, or Mission Duo-Chek quick closing, slow opening, quiet acting, non-slamming check valves shall be furnished in discharge lines from pumps and where indicated on the drawings or details.

K. Lubricated plug valves: 1 inch through 2 inches, Nordstrom No. 142, or Homestead No. 611, screwed ends; 2-1/2 inches and larger, Nordstrom No. 143, or Homestead No. 612, flanged ends, WP 175 psi WOG, with wrench and lubricant for specific service of the valve. Plug valves smaller than 1 inch shall be Crane 1228 iron body, bronze trim, 125 psi WOG.

L. Butterfly Valves:

1. All butterfly valves shall be lug type with lugs drilled and tapped to receive cap screws. Valves on insulated lines shall have extension necks and operators shall clear insulation.
2. Butterfly valves shall have ductile iron body aluminum bronze disk, 416 stainless steel stem, Buna-N, O-Ring stem seal, and Buna-N seat. Valves smaller than 6 inches for general service shall have 10-position leverlock type handles. Valves smaller than 6 inches for throttling service shall have throttling with memory stop type handles. Valves 6 inches and larger shall have enclosed gear type operators. Provide chain operators where valves are installed 8 feet or more above floor and where indicated on the drawings.
3. Valves on un-insulated lines shall be Norris No. 3310, Demco or Keystone; Norris No. 3200 in sizes above 12 inches.
4. Valves on insulated lines shall be Norris No. 3310, Demco or Keyston; Norris No. 3200 in sizes above 12 inches, with extension neck.

M. Ball valves shall be Mark Controls Corp., or equal, Marpac No. B780T bronze body, hard brass ball; TFE seat; TFE seals, in sizes 1/4 through 2 inches. Ball valves 3 inch and 4 inch sizes shall be Mark Control Corp. Marpac Series 410 or 470, ANSI Class 150, ductile iron, TFE seats; TFE seals. All ball valves shall be equipped with lever type operating handles.

N. Needle Valves: Crane #57 bronze needle valve, 300 psi with fiber seat.

O. Balancing Valves: DeZurik Series 100 non-lubricated, eccentric plug type valves or Illinois Products, Series 4000-5000, combination balancing and shutoff valves with an internal mechanism that can be set at the balance o=point so that the valve may be closed and opened, but not opened beyond the balance position. Valve bodies shall be brass or semi-steel, solder, screwed or flanged ends.

P. Lift check valves shall be Crane No. 366-1/2 iron body, Monel seat and disc in horizontal lines and No. 368 bronze trimmed in vertical lines.

Q. Pressure reducing and relief valves shall be designed for 150 psi WP and set as required. Pressure relief valves shall be in accordance with ASME Code, with discharge piped full size to floor drain.

R. Pressure reducing valves shall maintain a constant downstream pressure regardless of varying inlet side. Install a strainer and pressure gauge on inlet side and a pressure gauge on outlet side; install a 1" valved by-pass.

S. Automatic Flow Control Valves: Valves shall be Isolator™R, Isolator™Y and K Griswold (or Belimo) automatic pressure compensating flow control valves, or approved equal. Valves shall be factory set and shall automatically limit the rate of flow to required engineered capacity within 5% accuracy over an operation pressure differential. The control mechanism of the valve shall consist of a self-contained, open-chamber cartridge assembly with unobstructed flow passages that eliminate accumulation of particles and debris. Cartridge: AISI Type 304 stainless steel; AISI

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Type 17-7 PH stainless steel spring. Body: ½" SS 1 ½" – forged brass; 1 ½" L-3" – cast brass. End connections - brass. Valve shall have a thin orifice plate for self cleaning of the variable inlet ports over the full control range. Valve bodies shall be rated for use at not less than 150% of system designed operating pressures. Certified performance data for the flow control valve, based on independent laboratory tests, shall be available. All flow control valves shall be supplied by in-line strainer valves in a one-piece configuration consisting of a union, strainer, blow-down, pressure/temperature plug and ball furnished. Correct flow shall be verified by establishing that the operating pressure differential across the valve tappings is within number. The pressure measuring apparatus shall be portable and consist of a pressure gauge with a 4-1/2" diameter dial, instruction, hoses, and connections; and a pushbutton 3-way valve which transmits either of two pressures to a pressure gauge and a carrying case. Temperature monitoring is to be by insertion of a thermometer into the fluid media.

T. Pressure dependent Actuated Control Valves and Cartridge (Belimo).

1. The modulating control valves shall be pressure independent.

2. The pressure independent modulating control valve shall include a Pressure Compensating Cartridge, Actuated Ball Valve, and Manual Isolation Ball in a single valve housing.

3. Valve housing shall consist of forged brass, rated at no less than 360 psi at 250°F.

4. Valve shall have a fixed end or union end connection with factory installed air vent to allow for venting of the coil or heat pump.

5. The control valve shall accurately control the flow from 0 to 100% full rated flow.

6. A flow tag shall be furnished with each valve.

7. A universal mounting plate shall allow installation of actuators meeting the system electrical requirements and valve torque requirements as provided by Belimo, ELO Drive, Honeywell, Invensys, Johnson Controls, KMC, Neptronics, or Siemens.

8. The actuator and plate can be rotated after mounting.

9. Pressure Compensating Cartridge (PCC)
    a. PCC shall automatically compensate for pressure changes in valve and shall maintain a constant pressure drop across the flow limiting actuated ball.

    b. The operating pressure range shall be available with the minimum range requiring 5.8 PSID to actuate the mechanism.

    c. Valve internal control mechanism includes a diaphragm and full travel linear coil spring.

    d. Valves shall include an accessible/ replaceable cartridge.

    e. Dual pressure/temperature test valves for verifying the pressure differential across the cartridge and flow limiting ball shall be standard.

10. Actuated Ball Valve

    a. Valve ball shall consist of chemically plated nickel brass or stainless steel.

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b. Actuator stem shall be removable/replaceable without removing valve from line.

c. Manufacturer shall be able to provide ball insert to limit flow to maximum flow rate with ±5% accuracy.

d. Valve shall have EPDM O-rings behind the seals to allow for a minimum close-off pressure of 100 psi with 35 in-lbs of torque for 1/2" – 2" sizes.

e. Actuator shall provide minimum torque required for full valve shutoff position.

11. Isolation Ball Valve

1a. Valve shall include a 600 WOG manual isolation ball valve

12. Pressure Independent Control Valves and Pressure Dependent Control Valves shall be by Belimo Controls or pre-approved equal.

13. The control valve actuator may be furnished by the ATC contractor. The controls contractor is responsible for wiring and testing the valve actuators.

14. All components shall be warranted by manufacturer for no less than one year from date of purchase.

U. Calibrated Balance Valves (geothermal circuits) – Circuit Setter Plus, Bell and Gossett or approved equal.

V. This is a composite list of valves; all types may not be used on this project.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

B. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane unless unavoidable. Install valve drains with hose-end adaptor for each valve that must be installed with stem below horizontal plane.

C. Coordinate with control specifications sections 230900 and 230993.

3.02 GEAR OPERATIONS

A. Provide gear operations on all valves in six inch pipes or over.

3.03 CHAIN OPERATORS

A. Where noted or required for inaccessible overhead valves and valves over 8 feet above floor (except above finished ceilings), furnish chain operated handwheels, including rustproof chain and chain guide.

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3.04 FIRE PROTECTION

A. All valves on water supplies serving or connecting for fire service system shall be approved by the Authority Having Jurisdiction and shall be in conformance with NFPA standards.

3.05 VALVE CHARTS AND TAGS

A. Furnish and install on each valve a brass tag with black enamel number to indicate use, securely fastened to valve wheel. Also, provide valve chart in frame and glass cover showing the location and use of each valve. Valve charts shall be on 2000H paper, printed and set in glass covered frames and hung in Boiler Room, Equipment Room or where directed.

END OF SECTION

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SECTION 230524

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Air Separation Devices and Controls
B. Air Vents
C. Flow Measurement Devices
D. Pressure Gauges
E. Thermometers (see spec section 230519) Temperature Transmitters
F. Differential Pressure Transmitters
G. Suction Diffusers
H. Triple-duty Valves
I. Pressure and Temperature Test Plugs
J. Expansion Tanks
K. Strainers

1.02 SHOP DRAWINGS

A. Submit complete shop drawings including manufacturer's installation instructions.

1.03 ACCEPTABLE MANUFACTURERS

A. Bell and Gossett
B. Mueller
C. Taco
D. Weinman
E. Gerand
F. Griswald
J. Belimo

1.04 INSULATION EXTENSIONS

A. Provide factory built extensions on all air vents, measuring devices, gauges, thermometers, T&P test plugs, strainer drains and etc. to allow installation of pipe insulation.

1.05 SUBMITTALS

A. Submit catalogue cuts and shop drawings for each piece of equipment and tank.

PART 2 - PRODUCTS

2.01 AIR SEPARATION DEVICES AND CONTROLS

A. Bell and Gossett Rolairtrol as or ASL combination tangential air separator and system strainer, 125 psig, ASME Code constructed.

B. Bell and Gossett Airtrol tank fitting: Model AFT, ATFL, or proper size to match tank diameter. Line from system tank shall pitch upward to tank 1/4" per foot.

C. Automatic air vents: No. 7 with overflow connector and 1/4" OD copper tubing to floor drain. Install in all high points in the system.

D. Manual air vents: Crane Co. No. 702, 1/4" level handle petcocks.

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2.02 FLOW MEASUREMENT DEVICES

A. Data Industrial impeller flow sensors with non-magnetic sensing mechanism.

2.03 PUMP SUCTION DIFFUSERS

A. Provide suction diffusers on the suction side of centrifugal pumps as indicated on the drawings. Size shall match pump suction. Units shall have angle body, inlet vanes, combination diffuser, strainer, orifice cylinder with 3/16" diameter openings for pump protection. A permanent magnet shall be located within the flow stream and shall be removable for cleaning. The orifice cylinder shall be equipped with a disposable fine mesh strainer which shall be removed after system start-up. The orifice cylinder shall be designed to withstand the maximum shutoff head pressure differential of the pump. Unit shall have adjustable support foot. Units shall be suitable for working pressure to 175 psi and temperature to 300 F.

B. Manufacturers: Bell & Gossett, Mueller, Taco, Armstrong.

2.04 TRIPLE DUTY CHECK VALVES

A. Provide triple duty combination check-balancing-shutoff valves as indicated on the drawings. Valves shall be angle or straight-through type as indicated. Valve shall have adjustment features for balancing and memory stop for return to setting after shutoff. Check valve disc shall be quiet operating and provide tight shutoff in closed position. Valves shall have cast iron body, bronze trim, stainless steel stem, teflon-asbestos packing and shall be suitable for working pressures to 175 psi and temperature to 300 F.

B. Manufacturers: Bell & Gossett, Mueller, Taco, Armstrong.

2.05 PRESSURE AND TEMPERATURE TEST PLUGS

A. Provide where indicated (P&T Test Plug) "Pete's Plug", 1/4"-MPT fitting to receive either a temperature or pressure probe 1/8" OD. Fitting shall be solid brass with valve core of Nordel (Max 275 degrees F), fitted with a color coded and marked cap with gasket, and shall be rated at 1,000 psig. Provide two sets of temperature and pressure probes.

2.06 DIFFERENTIAL PRESSURE TRANSMITTERS

A. Provide complete, self-contained, variable capacitance type differential pressure transmitters equal to a Rosemount "Smart Transmitter" No. 1151.

B. The transmitters shall be installed by the contractor where indicated on the drawings. Wiring terminals and electronics shall be in separate compartments, so the electronics remain sealed during installation. Reverse polarity protection shall be included to keep wiring mishaps from damaging the transmitter. Wiring between the control system and the transmitter shall be Belden 9320, two wire, shielded twisted cable, and shall not be included in conduit containing AC circuit wiring.

Design range shall be as required by system. External zero and span adjustments, over-pressure to 2,000 PSI, and no humidity effects.

Minimum accuracy shall be 0.25% of calibrated span. Includes combined effects of linearity, hysteresis and repeatability. Stability shall be 0.25% of upper range limit for six months. No internal mechanical linkages shall be used in the transmitter(s).

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2.07 FLOW METERS

A. Provide dual turbine, insertion type flow meter(s) equal to a Onicon SF1210.

B. Wiring installed by the contractor between the control system and the meters shall be Belden 9320, two wire, shielded twisted cable, and shall not be included in conduit containing AC circuit wiring.

The meter shall have two contra-rotating axial turbines, each with its own rotational sensing system, and an averaging circuit to reduce measurement errors due to swirl in undeveloped flow locations caused by short straight pipe runs. Rotational sensing of each turbine shall be accomplished electronically by sensing impedance change and not with magnetic or photoelectric means. Paddle type rotors will not be acceptable.

The sensor shall have a maximum operating pressure of 400 PSI, maximum operating temperature of 180 deg F (optional 300 deg F peak) and a pressure drop of less than 1 PSI at 17 feet per second flow velocity. Flow sensor shall have 175:1 turndown ratio. Accuracy shall be within +-0.5% of actual reading at the calibrated typical velocity, and within +-2% of reading over a 50:1 turndown (from 0.4 to 20 ft/s). Each sensor shall be individually wet-calibrated in a flow laboratory against a primary volumetric standard accurate to within 0.1% and directly traceable to the U.S. National Institute of Standards and Technology (NIST). Provide certificate of calibration with each flow meter.

The sensor shall have integral analog outputs of 0-10 VDC and 4-20 mA linear to within +-0.1% of calibrated span for connection to the control system. The sensor shall also include three internal frequency outputs, (top turbine, bottom turbine, average frequency) for commissioning and diagnostic purposes. All outputs shall be linear with flow rate.

The turbine elements shall be made of polypropylene with sapphire jewel bearings and tungsten carbide shafts. The flow sensor shall be constructed of plated brass with an aluminum electronics enclosure and gasketed cover.

The unit shall be provided with hot tap installation, in order to be both insertable and removable through a ball valve when the pipe is under pressure.

2.08 TEMPERATURE TRANSMITTERS

A. Provide self-contained RTD type temperature transmitters. All temperature transmitters shall be packaged mounted and wired where possible.
The temperature transmitters shall each receive its power input and send its current output (4-20mA) over the same pair of low voltage wires. Each transmitter head shall be explosion proof.

B. The temperature probe shall use a platinum, wire wound, sensing element in a 316SS sheath, spring loaded, and inserted into a 3/4" NPT stainless steel thermowell with explosion proof process fittings and connection head. The thermowell shall penetrate one-half the pipe diameter.

The temperature range shall be [32-122 Deg F (0-50 Deg C) for chilled or condenser water] and [32-392 Deg F (0-200 Deg C) for hot water]. For applications measuring the supply and return temperatures for a loop type water system, the two probes shall be a matched pair.

The total system accuracy of the temperature transmitter/probe assembly shall be +/-01.00%

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of span; the sensing element and the transmitter shall be individually calibrated and traceable to NIST.

The stability of the transmitter/probe assembly shall be +/-0.01% of span/Deg C change in ambient temperature, +/-0.001% of span/volt change in line voltage, and +/-0.001% of span/100 ohms of lead resistance.

Wiring installed by the contractor between the control system and the transmitters shall be equal to Belden 9320, 2-wire, shielded, twisted cable and shall not be included in conduit containing wiring for alternating current.

2.09 LOW PRESSURE PIPELINE STRAINERS

A. Y-type with bronze or cast-iron body, screwed connections in sizes 2" through 2" and flanged ends in sizes 22" and larger, 125 psig working pressure. Strainer shall have screwed or bolted screen retainer with blowdown fitted with pipe plug; type 304 stainless steel screen with 1/32" perforations furnished in sizes through 2" and perforated brass screen, 3/64" openings for sizes 22" and larger.

B. Strainers shall have a gate valve and hose connection on the blowdown.

C. Manufacturers: Mueller, Armstrong, Illinois, Hoffman, Sarco or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Support air separation tanks and expansion from building structure. Provide hangers, bases, steel angle supports, etc. as required.

B. Install all devices in accordance with manufacturer's written instructions.

C. Coordinate with control specifications sections 230900 and 230993.

END OF SECTION

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SECTION 232113.33

GEOTHERMAL SYSTEM

PART 1 - GENERAL

1.1 REFERENCES

A. International Ground Source Heat Pump Association (IGSHPA) Installation Manuals.

1.2 SUBMITTALS

A. Submittals Package: Submit product data and quality control submittals specified below at the same time as a package.

B. Product Data: Manufacturers catalog sheets, specifications, and installation instructions for each item specified.

1. For piping, including manufacturer's name, schedule, type or class of pipe and fittings, and where optional materials are specified in the Pipe and Fitting schedule, indicate the option selected.

C. Quality Control Submittals:

1. Geothermal System Installers Qualifications Data:
   a. Name of each person who will be performing the geothermal work and their employers name and business address.
   b. Names and addresses of 3 similar projects that each person has worked on.
   c. Copy of installer’s personal accreditation as a GEOTHERMAL INSTALLER from IGSHPA.

2. Geothermal System Supervisors Qualifications Data:
   a. Name of person overseeing the geothermal work and their name and business address.
   b. Name and address of 3 similar projects that the supervisor has overseen during the past 5 years.
   c. Copy of installer’s personal accreditation as a GEOTHERMAL INSTALLER from IGSHPA.

3. Geothermal System Contractor's Qualifications Data.
   a. Names and addresses of 3 geothermal projects of similar size and complexity that the Supplier has worked on during the past 5 years.

D. Contract Closeout Submittals: Warranty - Copy of specified warranty.

1.3 QUALITY ASSURANCE

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A. Geothermal System Installer Qualifications: The persons performing geothermal work shall be personally accredited by IGSHPA, personally licensed as a geothermal installer, personally experienced in geothermal work, and shall have been regularly employed by a Company performing geothermal work for a minimum of 3 years.

B. Geothermal System Supervisor's Qualifications: The persons overseeing the geothermal work shall be personally accredited by IGSHPA, personally licensed as a geothermal installer, or piping, personally experienced in geothermal work, and shall have been regularly employed by a Company performing geothermal work for a minimum of 5 years.

C. Geothermal System Supplier Qualifications: The contractor shall have completed geothermal work on at least 3 projects of similar size and complexity within the last 5 years.

D. Regulatory Requirements:

1. Perform factory testing of factory fabricated equipment in complete accordance with the agencies having jurisdiction.
2. Perform field-testing of piping systems in complete accordance with the local utilities and other agencies having jurisdiction and as specified.

1.4 PROJECT CONDITIONS

A. Protection: During test work, protect controls, gages and accessories, which are not designed to withstand test procedures. Do not utilize permanently installed gages for field-testing of systems.

B. The existing school utilizes the closed loop geothermal system to provide the condenser water to the heat pump units. There are total of 90 (ninety) existing boreholes, 400 feet deep each and 2 (two) boreholes, 200 feet deep each. The 1” HDPE thermally fused at the bottom pipes were installed in each borehole and were grouted with the standard grout (K~ 0.34btu/hr*ft*F).

The 56 (fifty six) boreholes are located on the East side of the building and connected to the 15 (fifteen) supply and 15 (fifteen) return circuits. The 2” each supply and return circuits are connected to the main supply and return manifolds in the mechanical room.

There are total of thirty six (36) individual boreholes located on the South, West and North sides of the building perimeter. These boreholes are connected to the individual console heat pump units located in the classroom wings.

The 56 boreholes field was pressure tested (see the attached report). Since, no leak was detected, all the existing boreholes were planned to be reused as a part of the new HYBRID system. However, due to the earthquake event, which took place after the pressure test was conducted, the additional pressure test of the 56 boreholes field should be performed to ensure that no damage was done to the geothermal piping. The pressure test report should be issued and provided to the Owner, Architect and Engineer.

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The permanently installed pressure gauges and thermometers are required to be installed on the geothermal circuits, as indicated on the flow diagram drawing M5.1.

The existing supply and return manifolds in the mechanical room shall be extended by 48” to accommodate the new circuits (see the mechanical drawings).

Under the Base Bid the remaining thirty six (36) individual boreholes shall be disconnected from the existing console heat pump units and shall be abandoned in place.
Under the Alternative Bid (1 though 5) the thirty six (36) individual boreholes shall be pressure tested prior to connecting them to the new copper manifolds. If the borehole piping is determined to be leaky, it shall be capped. Just the functional (not leaky boreholes) shall be connected to the new system. A copy of the pressure test report shall be provided to the Owner, Architect and Engineer. Refer to the architectural spec for the Alternatives description.

The four (4) new copper manifolds should be installed in the crawl space (existing steam tunnels). The one (1) new copper manifold is located above ceiling in Area “D”.

1.5 SEQUENCING AND SCHEDULING

A. Transmit written notification of proposed date and time of pressure and operational tests to the Owner's representative at least 5 days in advance of such tests. Pressure test of the existing boreholes geothermal piping has to be conducted within the first 30 days of the contract.

B. Perform cleaning and testing work in the presence of the Owner's representative.

1.6 WARRANTY

A. Manufacturer's Warranty: Minimum 25 year warranty for polyethylene piping.

B. Special Warranty: 25 years for butt fusion welds in polyethylene piping against leakage.

1.7 PERMITS, LAWS AND REGULATIONS

A. The Contractor shall procure and pay for all permits, license, inspections, or approvals necessary for the execution of the contract.

B. The Contractor shall comply with all laws, ordinances, rules, orders and regulations relating to the performance of the work, the protection of property, the maintaining of surface passageways to buildings, fences, and/or other facilities.

C. All applicable Federal and State laws and regulations, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over the project shall apply to the contractor throughout and they shall be deemed to be included in the contract as part, thereof, the same as though herein written out in full.

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D. All regulations of the Occupational Safety and Health Act are in effect on this contract. It will be the Contractor's responsibility to make himself aware of all appropriate County, State and Federal regulations that apply to this contract.

E. Any violations incurred from improper execution of the above shall be paid by the Contractor. Loss of time on the project from such violations will not be tolerated.

1.8 WATER SUPPLY

A. The Contractor shall supply potable water as necessary to perform the work. The equipment will include pumps, water trucks or trailers, hoses, storage tanks and all other items necessary to provide an adequate supply of potable water. The source of water shall be subject to the approval of the Owner.

B. If excessive water quantity is presented during geothermal drilling, the geothermal contractor shall provide the water containment plan, which shall be approved by the Mechanical contractor and the Owner. The geothermal contractor is responsible for execution of the water containment plan.

PART 2 - PRODUCTS

2.1 PIPE & PIPE FITTINGS

A. High Density Polyethylene (PE) Pipe and Fittings: The piping shall be PE3408/4710 high density polyethylene. Resistance to environmental stress cracking is critical to long life expectancy. Therefore, as a more stringent requirement, the piping shall experience zero failures (FO) after 5,000 hours under condition AC@ (100% reagent at 100^{o}C) when tested in accordance with ASTM D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics@. A minimum 25-year limited warranty (in writing) must be issued by the pipe manufacturer. U-type fittings shall be shop fabricated under quality-controlled conditions of the same material designation.

B. Fittings:

1. Butt fusion type: ASTM D3281
2. Socket fusion type: ASTM D 2683
3. Install as a U configuration at bottom of well. U-bend fitting shall be factory installed.

C. Acceptable Manufacturers:

1. Charter Plastic
2. Performance Pipe;
3. Endot Industries
4. Flying "W" Plastics

D. Joining and Sealant Materials: Thread Sealant:

1. Lake Chemical Co, Slic-Tite
2. Locite Corp. pipe sealant with Teflon

E. Packing Materials for Building Construction Penetrations:

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1. Oakum: FS A-A-1186.

2.2 TESTING MATERIALS

A. Test Equipment and Instruments: Type and kind as required for the particular system under test.

B. Test Media (air, gas, water): As specified for the particular piping or system being cleaned.

C. Cleaning Agent (chemical solution, water): As specified for the particular piping, apparatus or system being cleaned.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install the work of this section in accordance with the manufacturer's printed installation instructions.

3.2 MOBILIZATION/DEMOBILIZATION

A. Mobilization shall consist of furnishing at the project site, labor, power, supplies, tools, equipment and performing operations in connection with the completion of the pressure testing and connection of the existing geothermal heat exchanger to the new system.

B. Demobilization shall consist of the removal from the construction site of all plant, equipment, supplies and personnel after completion of the work including the cleanup of all rubbish, litter and waste materials generated by the Contractor’s activities. Drill cuttings are not to be utilized as part of borehole construction.

3.5 INSTALLATION – PIPING

A. Horizontal Piping:

1. Separate pipes by a minimum of six (6) inches horizontally and vertically. Tag header designation numbers.

   a. Minimum pipe depth - 48" below finished grade.
   b. Insulate piping at wall penetrations.

2. Separate supply and return lines or bundles a minimum of 6-12 inches to minimize thermal interference.
3. Minimize the number of points where supply and return lines cross one another.
4. Install piping of such lengths to minimize the number of fusion joints required.
5. Avoid sharp bends in piping, use elbows where required.
6. Install bell reducing fittings or reducing tees at pipe reductions to eliminate trapped air.

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7. Cap open end of pipe to prevent entry of contaminants until final connections are made.
8. Pressure test piping.

C. Pipe Joint Makeup:

1. Polyethylene Butt or Saddle (side wall) Fusion Pipe Joints: Follow the manufacturer's printed installation instructions.
2. Dissimilar Pipe Joints;
   a. Joining Dissimilar Threaded Piping: Make up connection with a threaded coupling or with companion flanges.
   b. Joining Dissimilar Non-Threaded Piping: Make up connection with adapters recommended by the manufacturer's of the piping to be joined.

3.6 INSTALLATION - EQUIPMENT

A. The fusion machine shall encompass the following feature:

1. Guide rods shall be in the plans that passes through the centerline of the pie thus canceling the bending forces in the machine caused by the fusion forces.
2. The combination butt/saddle machine must have a mechanical advantage of at least 5.5 to 1 in the butt fusion mode, and 2.5 to 1 in the saddle fusion mode. A butt fusion only machine must have a mechanical advantage of at least 10 to 1 and saddle fusion only machine must be capable of applying at least 600 lbs of thrust.
3. The pipe clamps shall have the strength to Around-up@ the pipe close to the fusion joint. They must be adjustable for removal of high/low mismatch of pipe walls, and clamp each piece on a continuing straight centerline.
4. The pipe facing device shall be capable of rapid facing of the pipe ends to a perfectly flat surface, so when the ends are brought together, there is 100% plastic contact. The facer shall be hand-powered for pipe sizes up to 2", electrically powered up to 8", and hydraulically powered for sizes larger than 8". The facer shall have precisely machined stops to lock the facer squarely between the clamping jaws at the end of face off.
5. The heater plate shall be electrically heated and thermostatically controlled. The surface shall be smooth with a high quality non-stick coating. The heater shall be capable of quick heat-up and maintaining a constant surface temperature in the desired temperature range even in inclement conditions. The heater plate shall be equipped with a thermometer to monitor proper temperature.

3.7 PIPE CLEANING AND TESTING

A. Preliminary Work: Thoroughly clean pipe and tubing prior to installation. During installation, prevent foreign matter from entering systems. Prevent if possible or remove obstructions from piping and systems.

B. Flushing, Purging, Pressure and Flow Testing:

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1. All fusion joints and loops lengths shall be checked to verify that no leaks have occurred in shipping or in fusion joining.
2. All loops will be pressure tested.
3. Heat exchangers will be tested, as specified in section 3.9.
4. Cleaning: Upon completion of the pressure testing, completely flush the geothermal, earth coupled heat exchanger with clean water. Continue flushing at a velocity high enough (not less than 2 ft/sec) to remove all air from piping system. Do not use chemical cleaning solutions. Keep the earth-coupled heat exchanger completely disconnected from the indoor piping system while flushing operation is being performed. Do not connect the heat exchanger to the indoor piping system until the indoor system has been thoroughly cleaned and flushed.
5. Flow rates and pressure drops will be compared to calculated values to assure that there is not blockage or kinking of any pipe.
6. A minimum velocity of 2 ft./sec in each piping section must be maintained for a minimum of 15 minutes to remove all air. A change of more than one inch in the level of fluid in the purge pump tank during pressurization indicates air still trapped in the system.

C. Balancing: Balance pipe loop flow to quantities indicated on drawings.

3.8 SYSTEM IDENTIFICAITON AND INSTRUCTION TO WONERS PERSONNEL

A. Submit a shop drawing showing the dimensioned layout of the new installation.

3.9 HIGH DENSITY POLYEHYLENE PIPE TESTING PROCEDDURE

A. High Density Polyethylene (HDPE) pipe testing should be conducted as required by ASTM F 2164-02 Procedure. The purpose of the test is to insure that the ground heat exchanger (GHEX) does not have leaks. The test process is under the ASTM 2164-02 guidelines and is the industry standard.

B. The basics of the test are:
   a) Flush and purge all air from the piping to be tested.
   b) Close off by valves the piping to be tested.
   c) Slowly, add water with a positive displacement pump to raise the system pressure to the maximum determined by the responsible parties.

C. The maximum pressure is 1.5 times the design working pressure less the elevation hydrostatic head. An example: if the static water level in a vertical geothermal heat exchanger is one hundred feet below the surface; one must reduce the testing pressures; to not over pressure the vertical piping. If the loops are 300 feet in depth the them maximum pressure for SDR-11 PE testing is 1.5 times the design (1.5 x 160= 240 psig) less 100 feet of dry borehole or (100 x .4335= 43.35 psi reduction) therefore, it is 240 minus 43.35 or 196.65 psig maximum testing pressure.

D. Typical design pressures for: SDR-9 is 200 psi, for SDR-11 is 160 psi, and SDR-13.5 is 128 psi; and are to be reduced for higher temperatures.

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Typically, the design temperature for HDPE is 73.4 °F. Usually it is the horizontal sections of the GHEX that are above this temperature. Consult the HDPE manufacturer for the temperature reductions for pressure ratings.

a) Allow the test section of piping and test liquid to equalize in temperature.
b) Add make up water as necessary for four (4) hours to maintain test pressure.
c) Reduce pressure by ten (10 psi), by letting water out and then closing the system.
d) Monitor for one (1) hour, do not increase pressure or add water.
e) Pass/Fail Criteria: if no leakage is visually observed and the pressure remains steady (within 5%) then a passing test is indicated.

E. The following geothermal piping shall be tested under this contract:
1. Fifteen (15) geothermal circuits, which connect the 56 boreholes (East side) to the geothermal manifolds in the mechanical room.
2. Thirty six (36) individual boreholes located on the South, West and North sides of the building. Refer to the new construction an existing (as-built) drawings for the geothermal piping location.

END OF SECTION

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SECTION 235216

MULTIPLE CONDENSING BOILER HEATING PLANT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Manufacturer shall provide boilers in accordance with all codes and authorities having jurisdiction, drawings, schedules and specifications. Mechanical contractor shall receive and install the boilers according with this specification, drawings, manufacturer and owner requirements.
Boilers shall be UL/FM approved. Boiler manufacturers: Lochinvar, AERCO International, Inc. or approved equal.

1.2 SUBMITTALS

A. Submit manufacturer's data on showing complete performance capacity.

B. Submit dimensioned drawings of boilers showing accurately scaled boilers and components; include layouts, and space relationships to associated piping and equipment.

C. Provide appropriate Certificates of Shop Inspection and Field Assembly Inspection as required by provisions of ASME Code.

PART 2 - PRODUCTS

2.1 BOILER CONSTRUCTION

A. The BOILER shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. There shall be no banding material, bolts, gaskets or "O" rings in the header configuration. The BOILER shall have a 316L stainless steel heat exchanger. The combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly including a condensate trap. The complete heat exchanger assembly shall carry a ten (10) year limited warranty.

The BOILER shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The BOILER shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the ASHRAE 103 Standard. The BOILER shall operate at a minimum of 94% thermal efficiency at full fire on 1,000,000, 1,300,000 and 1,500,000 Btu/hr models. All models shall operate up to 98% thermal efficiency with return water temperatures at 90°F or below. The BOILER shall be certified for indoor installation.

The BOILER shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The BOILER shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates

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for maximum efficiency. The BOILER shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column.

The BOILER shall utilize a 24 VAC control circuit and components. The control system shall have a Liquid Crystal touch screen display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front of the jacket. The BOILER shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi; outlet water temperature sensor; return water temperature sensor; outdoor air sensor, flue temperature sensor; high and low gas pressure switches, low water cut off with manual reset and a condensate trap for the heat exchanger condensate drain.

The BOILER shall feature the “Smart Touch” control with a Liquid Crystal touch screen display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, domestic hot water prioritization and PC port connection. The BOILER Shall have contacts for any failures, runtime contacts and data logging of runtime, ignition attempts and failures. The BOILER shall allow 0-10 VDC input connection for BMS control and have built-in “Cascade” to sequence and rotate while maintaining modulation of up to eight boilers without utilization of an external controller. The control may be compatible with optional Modbus communication.

The BOILER shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Louver Proving Switch, two Flow Switches, Tank Thermostat, Remote Enable/Disable (Wall Thermostat/Zone Control), System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single phase. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump, the Boiler pump and the Domestic Hot Water pump. The System pump and boiler pump dry contacts shall be sized for up to 1.5 hp/120V, 3 hp/240V or 30 amp pumps.

B. Boiler modules shall be of gas fired, condensing design with a modulating power burner and positive pressure discharge. Each boiler shall be capable of 10:1 turndown of firing rate without loss of combustion efficiency. Heat exchanger/combustion chamber shall incorporate a helical fire tube design that will be self supporting, baffle free, and warranted to withstand thermal shock. Heat exchanger shall be ASME stamped for working pressure not less than 150 psig. Unit shall have an ASME approved relief valve with a setting of 75 psig. Exhaust manifold shall be of corrosion resistant porcelain enameled cast iron, with a 6" diameter flue connection. Exhaust manifold shall have a gravity drain for the elimination of condensation with collecting reservoir.

C. The flame monitoring system shall incorporate a UL recognized combustion safeguard system utilizing interrupted spark ignition and a rectification type flame sensor. An electro-hydraulic double seated safety shutoff valve shall be an inherent part of the gas train.

D. Each boiler module shall incorporate electric probe type low water cutoff and dual over temperature protection including a manual reset in accordance with ASME section IV and CSD-1. Remote fault alarm contacts, sensor failure detection, and auxiliary contacts shall be standard equipment. Boilers shall operate on 120/1/160.

2.2 CONTROLS

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A. Boiler manufacturer shall supply as part of boiler package a completely integrated control system to control all operation and energy input of the multiple boiler plant. The system shall be comprised of a microprocessor based control utilizing pulse width modulation for bumpless transfer of header temperature and sequential firing. The controller shall have the ability to vary each individual module input throughout its full range to maximize the condensing capability of the module and the entire plant without header temperature swings. BMS shall provide contact closure for automatic adjustable heat start circuit for plant activation and have contact closure for auxiliary equipment such as pumps and combustion air dampers.

B. Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. The system shall be comprised of a microprocessor based control utilizing pulse width modulation for bumpless transfer of header temperature. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler and without header temperature swings.

C. The plant will operate to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied. Maximum efficiency shall be achieved at minimum firing input. Main header outlet temperature shall not be more than □ 2F from setpoint at any point of operation.

2.3 WARRANTEE

A. The pressure vessel of boiler shall carry an unconditional 10 year warranty against leakage due to defective materials or workmanship. The heat exchanger tubes/combustion chamber assembly shall be warranted against failure due to thermal stress failure or corrosion for a five year period. A Warranty Certificate must be issued to the owner from the manufacturer and a copy of the warranty be submitted for Engineers approval.

B. The boiler system and the control system shall be guaranteed for **two** years.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All aspects of installation of Boiler Plant shall be in strict accordance with manufacturer's instructions. Materials shall conform with all manufacturer's recommendations and shall include a Stainless Steel AL-29-4C Positive Pressure UL listed Vent System, or PVC, as required by the boiler manufacturer. Boiler plant piping shall be field constructed of materials as specified. Each boiler shall have individually isolating shutoff valves for service and maintenance.

B. Install boilers where shown, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that boilers comply with requirements and serve intended purposes. Comply with requirements of state and local boiler codes, and applicable provisions of NFPA and ASME boiler code standards.

C. Provide and install supply water temperature sensor, manual reset hi-limit, temperature/pressure indicator gauges, flow balancing valves, transformer and all necessary control wiring and devices.

D. Coordinate with other work (plumbing, heating and gas piping) as necessary to interface installation of boilers with other components of the system.

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E. Flush and clean boilers upon completion of installation in accordance with manufacturer's instructions.

F. Start-up cast-iron boilers in accordance with manufacturer's written procedures, and demonstrate compliance with requirements.

G. Provide PVC condensate drains to floor drain.

3.2 VENT SYSTEM

A. The vent system will include breechings and stacks. System will be all stainless steel, dual wall and UL approved for installation with condensing type boiler, or PVC.

B. The chimney support shall be specifically designed for the chimney and shall be tested, approved and listed by the Underwriters Laboratories. This support shall be capable of supporting four times the combined weight of the chimney installation.

C. Provide ventilated roof thimble, rain cap, flashing storm collar assembly and accessories to complete chimney system.

D. Installation shall comply with the terms of the UL listing, manufacturer's instructions and local building code.

3.3 FIELD SERVICES

A. Contractor shall provide the services of a local factory authorized representative to supervise all phases of equipment start-up. A letter of compliance with all factory recommendations and installation instructions shall be submitted to the engineer with operation and maintenance instructions.

END OF SECTION

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SECTION 236500

COOLING TOWER
CROSS-FLOW DESIGN

PART 1 - GENERAL

1.1 DESCRIPTION

A. Manufacturer shall provide cooling tower in accordance with the drawings, schedules and specifications. The extent of work is indicated by drawings and schedules and by requirements of this section. Each unit is defined to include (but not by way of limitation) casing, fans, drives, motors, sump, and controls and auxiliary components, accessories and interconnecting piping.
Mechanical contractor shall receive and install one factory-assembled, induced draft, crossflow cooling tower with vertical air discharge conforming in all aspects to the specifications, schedules and as shown on the plans. Overall dimensions shall not exceed approximately 12 ft long x 9_ ft wide x 11 ft high. The total connected fan horsepower shall not exceed 7-1/2 HP. The cooling tower shall be Baltimore Aircoil Company , Marley Cooling Technologies, Evapco or approved equal.

B. UL Labels: Provide electrical components that have been listed and labeled by Underwriters Laboratories.

C. NEMA Compliance: Comply with applicable portions of National Electrical Manufacturers Association standards pertaining to motors.

D. The cooling tower manufacturer shall have a Management System certified by an accredited registrar as complying with the requirements of ISO-9001:2000 to ensure consistent quality of products and services.

E. Manufacturer The cooling tower shall be Baltimore Aircoil Company , Marley Cooling Technologies, Evapco or approved equal.

F. Warranty: fan, fan shaft, bearings, mechanical equipment support, and fan motor shall be warranted against defects in materials and workmanship for a period of five (5) years from date of shipment.

1.2 SUBMITTALS

A. Submit manufacturer's data on cooling tower, including certified drawings, showing overall dimensions of complete assembly, operating weights, foundation requirements, sizes, and locations of connections, accessories, auxiliary support requirements, and parts lists. Include the following information:

1. Performance certifications and reports.
2. Wiring diagrams showing electric service for unit's electrical components, safety devices and indicator lights.
3. Written instructions for installation and assembly.
4. Written operating instructions including start-up, routine and normal operations, regulations and controls and shutdown for emergency.

PART 2 - PRODUCTS

2.1 COOLING TOWER

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A. Furnish and install, as shown on the plans, factory-assembled Baltimore Aircoil induced draft cross-flow cooling tower with vertical air discharge. Unit construction shall be all hot-dip galvanized steel with the Baltibond corrosion protection finish, or stainless steel basin.

B. The unit shall be suitable for applications requiring equipment anchorage to resist wind loads up to 30 psf acting on the full vertical projected area with 16 psf acting simultaneously on the full horizontal projected area or seismic forces of 161% of the operating weight acting in the horizontal direction, and 24% of the operating weight acting in the vertical direction applied at the center of gravity. Loads are appropriate for Seismic Zone 4 assuming an Importance factor of 1.0, and soil profile SD, and rigid mounting to the supporting structure per current Uniform Building Code.

C. Casing shall be constructed of steel panels supported by heavy gauge angle framework. Access doors shall be provided for access to eliminator and plenum section. Louvers shall prevent water splash-out during fan cycling and be constructed of maintenance free, corrosion resistant, UV protected, fiberglass reinforced polyester (FRP).

D. Steel cold water basin shall be self-cleaning and include depressed center sump, with drain and clean-out connections. Suction connection shall be provided with anti-cavitation device and strainers.

E. Hot water distribution basins shall be open gravity type with distribution weirs and plastic metering orifices to assure even distribution of water over wet deck surface.

F. Wet deck shall be manufactured and performance tested by the cooling tower manufacturer and shall be 20 mils thick polyvinyl chloride wave-formed sheets. It shall have a flame spread rate of 5 per ASTM E84-77a and shall be Factory Mutual approved.

G. The drift eliminators shall be PVC as specified above. They shall have a minimum of three distinct changes in air direction and limit drift loss to less than 0.2% of the total water circulated.

H. Fans shall be cast aluminum, fixed-pitch with a minimum of six blades driven through a one-piece, multi-groove "POWERBAND" or gear reducer. Fan shall discharge through a steel fan cylinder designed for streamlined air entry and minimum tip loss for maximum fan efficiency. Fan discharge shall include a heavy gauge wire fan guard. Fan shall be a low sound fan to keep tower noise down.

I. Fan motor shall be totally enclosed 1800 RPM, squirrel cage, ball bearing type with special moisture protection on windings, shafts and bearings.

J. Louver Face Platform: Easy access to the hot water basins for inspection and maintenance of the basins, even during tower operation, shall be provided by louver face platforms. Fan deck ladders and handrails, which add to the overall height of the tower, are not acceptable.

K. Provide galvanized steel distribution basin covers with handles for ease in removal.

L. Provide air inlet screens to prevent debris, such as leaves, paper, etc., from entering tower. Screens shall be constructed of 1" x 1" hot-dip galvanized wire mesh with U-slip frames.

M. Provide vibration cutout switch to de-energize fan motor should vibration occur due to imbalance of the fan.

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N. Supply electric immersion heaters sized to maintain basin at 40°F at 0°F ambient. Heater shall be the size, type and electrical characteristics called for on the plans.

O. Supply factory installed electric thermostat and low water protection relay and contactor. Enclosures shall be weatherproof. Power and control wiring shall be done by the contractor.

P. The cooling tower shall be furnished with a control panel that ships loose for field mounting. The control panel will include a variable frequency drive, bypass starter, contactors, branch circuit protection and all electrical controls required to properly operate the cooling tower fan motor(s) and basin heater(s) with both mechanical as well as electrical interlocks. Standard features include both manual and automatic operation, internal power and control wiring, selector switches, control transformer, and status indicating lights.

The electrical enclosure shall be a NEMA 3R steel cabinet with an ANSI 61 gray coating and include a HMCP and a disconnect switch with a lockable, external, operating handle.

The control power transformer shall step down primary voltage to 120/1/60 and include two fuses on primary side, single fusing on secondary side.

The cabinet shall incorporate status indicating lights for POWER ON, INVERTER, BYPASS and HEATER ON

The control panel shall include a factory mounted and wired, pulse-width modulating variable frequency drive (VFD) utilizing IGBT and microprocessor technology. The VFD shall be sized for the cooling tower fan motor horsepower and include a three-contactor bypass circuit. Mode shall be selectable via an Inverter-Off-Bypass selector switch.

A thermostatically controlled heater shall be provided to inhibit condensation inside the control panel.

A thermostatically controlled cooling fan shall be provided to draw air across the VFD and provide cabinet air circulation.

The control panel shall include a terminal strip to interface with the cooling tower basin heater control devices, the vibration cutout switch, the electric water level controller and the ALC (Automatic Logic Control) system.

A terminal strip for the 120-volt control circuit shall be provided to allow for a field supplied dry contact to start and stop the cooling tower cooling function. The contact will not disable the tower basin heater circuit (if supplied). The building automatic temperature control, ALC, system shall provide the dry contact for the cooling function as well as the analog, 0-10 VDC or 4-20 mA reference signal to control the condenser water temperature by varying the motor fan speed through the VFD. In addition, the following points shall be provided for monitoring by the ALC system: Inverter Selected, Bypass Selected, Inverter Fault Alarm, Inverter Run, Basin Heater On, Tower High Water Alarm, Tower Low Water Alarm, Analog Output for Motor Amps (4-20mA)

Fan motor(s), basin heaters, temperature sensors and any remote control devices supplied for the cooling tower must be field wired to the control panel.

Basin Water Level Control: The cooling tower manufacturer shall provide an electric water

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level control (EWLC) system. The system shall consist of water level sensing and control units in quantities and locations as indicated on the drawings. Each water level sensing and control unit shall consist of the following: NEMA 4 enclosure with gasketed access cover; solid state controls including all necessary relays and contacts to achieve the specified sequence of operation; stainless steel water level sensing electrodes with brass holder; Schedule 40 PVC standpipe assembly with vent holes, and all necessary stainless steel mounting hardware. Provide PVC union directly below the control enclosure to facilitate the removal and access of electrodes and control enclosure.

The number and position of water level sensing electrodes shall be provided to sense the following: high water level, low water level, high water alarm level, and low water alarm,
A slow closing solenoid valve shall be provided with the electric water level control system for remote mounting either at the cooling tower or in the mechanical room as indicated on the mechanical drawings. The solenoid valve shall supply makeup water to the open loop condenser water system on demand from the tower level controller.

The control panel shall come fully assembled, internally wired, and bench-tested prior to shipment.

Q. Provide an aluminum ladder for access to the top of the cooling tower. Ladder shall extend from the roof to the top of the cooling tower. Provide a safety cage attached to the top of the ladder.

R. Cooling tower performance shall be certified by the Cooling tower institute as provided in standard STD-201 or, lacking such certification, a field performance test shall be conducted within the one year warranty period and in accordance with CTI Acceptance Test Code ATC-105. The test shall be supervised by an independent test and balancing company as approved by the Engineer. The cooling tower manufacturer shall include in the bid price all costs for instrumentation as well as preparation and conducting the Cooling Tower Institute field performance test. Should the field performance test prove the tower performance deficient, the Owner shall be reimbursed by the cooling tower manufacturer for any power increase required to meet the performance specification. The tower shall be retested and certified after all deficiencies are corrected. Test reports shall be submitted to the Engineer and Owner at the test conclusion by the testing company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Except as otherwise indicated, install cooling tower equipment work, including components and controls required for operation, in accordance with manufacturer's instructions and with recognized industry practices to ensure that equipment complies with requirements and serves intended purposes.

B. Locate units in general position indicated in relation to other work. Position units with sufficient clearance for normal service and maintenance, including clearance for cleaning and clearance for component replacement.

C. Reinstall all water treatment piping connections.

END OF SECTION

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SECTION 237200

ENERGY RECOVERY HEAT PUMP UNIT

1. GENERAL

1.1. Provide outside air units as manufactured by Valent, Engineered Air, Mammoth, Aaon or approved equal.
1.2. Project is based on the specified equipment (Valent). Any additional costs associated with using alternate manufacturer's equipment shall be borne by the installing contractor or equipment provider.
1.3. Equipment shall be completely assembled, piped, internally wired and computer run tested at the factory. Equipment Manufacturer shall provide computer test results upon request of owner. It shall be both ETL and ISO-ARI 13256-1 Standard ISO (Ground Loop Heat Pump) listed and labeled prior to leaving the factory. Service and caution area labels shall also be placed on the units in their appropriate locations.

2. WARRANTY

2.1. Unit shall be subject to manufacturer's standard warranty for the following periods:
1. Overall unit, 12 months from substantial completion but no more than 18 months from shipment.
2. Compressors, 60 months substantial completion but no more than 66 months from shipment.
3. Energy recovery wheel, 60 months from substantial completion but no more than 66 months from shipment.

3. CASING CONSTRUCTION

3.1. Units shall be constructed for outdoor installation. Structural supports for the Energy Recovery Units (ERU) shown on the construction documents drawings and shall be provided and installed by the mechanical contractor. Manufacturer shall provide the roof curb for ERU-5 only.
3.2. Base
1. Base rails shall be constructed of a minimum of 10 gage galvanized steel with 16 gage integral floor pan.
2. Base shall have a minimum 4" overhang over the top of a roof curb to prevent water infiltration.
3. All floor seams shall have a raised rib joint.
4. There shall be no penetrations through the floor of the unit within the perimeter of the curb except for duct openings and utility chases.
5. Penetrations through the floor shall have a ½" raised rib around each opening.

3.3. Base pan

1. Base pan shall be insulated with ½" closed-cell neoprene liner.

3.4. Panels

1. Casing shall be constructed with minimum 2-inch, foam-injected, double-wall panels.
2. Individual panels shall be constructed so that they are thermally broken (there shall be no metal-to-metal contact between the interior and exterior sheet metal of each panel).
3. Interior side of panel shall be 22 gage G-90 galvanized steel.
4. Exterior side of panel shall be 22 gage painted steel rated for 1000 hours in accordance with ASTM B117 and ASTM D1654.

5. Insulation

5.1. Insulation shall be 2 lb/ft^3 foam insulation with an average R-value of 6 per inch.
5.2. Insulation water absorption must be no more that 0.038 lb/ft per ASTM D 2842 and show "no growth" per ASTM G21 biocide testing.
5.3. No insulation shall be exposed to the air stream.
5.4. Fiberglass insulation is not acceptable due to possibility of sloughing and moisture retention.

3.5. Access doors

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1. Access doors shall be provided for access to all components requiring regular maintenance or inspection.
2. Access doors shall have a minimum of two quarter-turn compression latches with adjustable catches.
3. Access door construction shall be identical to unit casing.
4. Interior side of access doors shall be 22 gage G-90 galvanized steel.
5. Exterior side of panel shall be 22 gage painted steel rated for 1000 hours in accordance with ASTM B117 and ASTM D1654.
6. Access doors shall be sealed with a full-perimeter gasket constructed of Mylar-encased low-density foam.
7. Insulation
   - 7.1. Insulation of shall be 2 lb/ft^3 foam insulation with an average R-value of 6 per inch.
   - 7.2. Insulation water absorption must be no more that 0.038 lb/ft per ASTM D 2842 and show "no growth" per ASTM G21 biocide testing.
   - 7.3. No insulation shall be exposed to the air stream.
   - 7.4. Fiberglass insulation is not acceptable due to possibility of sloughing and moisture retention.

3.6. Weatherhood with bird screen shall be provided on outside air inlet.
3.7. Roof shall be pitched with a minimum ½" roof overhang around the perimeter of the unit.

4. BLOWERS/MOTORS

4.1. Blowers
1. Fan assemblies shall be direct-drive without the use of belts or adjustable sheaves.
2. Manufacturer shall provide a variable frequency drive for each fan section.
3. Variable frequency drive shall be mounted, wired, and programmed by the manufacturer.
4. Variable frequency drive shall be located in an enclosed compartment outside of the supply or exhaust air stream.
5. Fan wheels shall have backward inclined blades constructed out of corrosion-resistant, fiber-reinforced polyamide.
6. Fan wheel shall be tested in accordance to AMCA 210.
7. Fan assemblies shall be mounted on rubber in shear isolators

4.2. Motors
1. Fan motor shall be VFD rated, ODP type, EPACT compliant.
2. Fan motor shall be of premium efficiency (PE).

5. DAMPERS

5.1. Motorized dampers
1. Frame shall be constructed of a 16 gage galvanized steel hat-channel.
2. Blades shall be constructed of 16 gage galvanized steel strengthened by three longitudinal 1 inch deep "vee" grooves.
3. Blades shall be symmetrical relative to its axle pivot point.
4. Axle bearings shall be synthetic sleeve-type and rotate inside extruded holes in the damper frame.
5. Blade seals shall be extruded vinyl permanently bonded to the appropriate blade edges.
6. Frame shall include flexible stainless steel compression-type jamb seals.
7. Modulating spring-return actuators shall be provided by the factory, installed on the damper, and wired to the control center.
8. Damper leakage shall be no more than 5 cfm/sq.ft. at 1 in.wg static pressure.

6. FILTERS

6.1. Outdoor air intake hood
1. Filter rack shall accommodate 2" media.
2. Manufacturer shall provide 1 set of 2" aluminum filter media.
3. Filter sections shall be accessible outside the unit and located in the outdoor air intake hood.

6.2. Outdoor air filters
1. Outdoor air filter rack shall accommodate factory-provided 2" aluminum filters.

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2. Filter sections shall be accessible through a 2" foam-injected, double-wall, hinged access door with quarter-turn latches.

6.3. Supply air filters
1. Supply air filter rack shall accommodate 2" MERV 8, filters.
2. Filter sections shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.

6.4. Return air filters
1. Return air filter rack shall accommodate factory-provided 2" pleated filters.
2. Filter sections shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.

7. ENERGY RECOVERY – ENTHALPY WHEEL

7.1. Energy recovery shall be an integral part of unit from the manufacturer.
7.2. No field assembly, ducting, or electrical wiring shall be required with energy recovery.
7.3. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer.
7.4. Construction
1. Energy recovery wheel shall be constructed of lightweight polymer substrate with permanently-bonded silica gel desiccant.
2. Individual pie-shaped wheel sections shall be removable from wheel cassette for maintenance.
3. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.
4. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
5. Energy wheel cassette shall include seals, drive motor and drive belt.
7.5. Latent energy shall be transferred entirely in the vapor phase.
7.6. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety.
7.7. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and factory wired to main ventilator disconnect.
7.8. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and ARI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.
7.9. Energy recovery wheel cassette shall be mounted perpendicular to the base of the unit.
7.10. Energy recovery wheel cassette shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.

8. COOLING - WATER-SOURCE HEAT-PUMP

8.1. Unit shall be provided with factory piped, charged, and tested packaged water source heat pump direct expansion refrigeration system.
1. All refrigeration systems 13 nominal tons and above shall be equipped with two stages of capacity control, each on an independent refrigerant circuit.
8.2. Refrigeration system shall be provided with thermal expansion valve (TXV) incorporating adjustable superheat.
8.3. Evaporator coil
1. Coil shall be rated in accordance to ARI standards and pressure tested for 250 psi working pressure.
2. Coil shall be a minimum of 4 rows deep.
3. Refrigeration systems with more than one circuit shall have interlaced evaporator coils.
4. Coil casing shall be constructed of 16 gage galvanized steel.
5. Coil tubes shall be constructed of 1/2" diameter, 0.016" thick seamless copper tubing.
6. Coil fins shall be constructed of 0.0060" thick aluminum.
8.4. Drain pan
1. Drain pan shall be constructed of a minimum of 18 gage 201 stainless steel.
2. Drain pan shall be double-sloped to ensure condensate removal from unit.
3. Drain pan shall extend a minimum of 8” past the evaporator coil to ensure condensate retention.
8.5. Modulating hot-gas reheat

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1. Hot-gas reheat coil shall be separated from the evaporator coil by a minimum of 6” in the direction of airflow to prevent the re-evaporation of condensate, provide room for coil cleaning, and allow control system to monitor evaporator coil leaving air temperature.
2. Hot-gas reheat coil shall be constructed entirely of aluminum.
3. Hot-gas reheat shall be controlled through a factory-supplied modulating control valve.

8.6. Compressors
1. Compressors shall be hermetic scroll type and include the following items:
   1.1. Suction and discharge service valves.
   1.2. Reverse rotation protection.
   1.3. Oil level adjustment.
   1.4. Oil filter.
   1.5. Rotary dirt trap.
   1.6. Short cycling control.
   1.7. High and low pressure limits.
   1.8. Crankcase heaters.
2. Compressors shall be installed in an isolated compartment separate from supply airflow, return airflow, microprocessor controller, non-fused disconnect, compressor relays, fan motor VFD, and all other electrical components inside the unit.
3. Compressors shall be installed using manufacturer's recommended rubber vibration isolators.
4. Lead refrigeration circuit shall utilize Digital Scroll™ compressor capable of 10:1 turndown.

8.7. Water-to-refrigerant heat exchanger
1. Each independent refrigerant circuit shall be provided with a coaxial water-to-refrigerant heat exchanger.
2. Each independent water-to-refrigerant heat exchanger shall be equipped with a factory supplied and mounted [two-way, three-way] valve with modulating actuator.

9. ELECTRICAL

9.1. Units shall be factory wired with a single point power connection.
9.2. Units shall be wired according to NEC and listed per ETL.
9.3. ETL listing shall cover all components of the ventilator and not be limited to the control panel.
9.4. All major electrical components shall be UL listed.
9.5. Unit shall be constructed with an integral control center isolated from supply airflow, exhaust airflow, compressors, and heating elements.
9.6. The following items shall be provided and wired within the control center by the factory:
1. Non-Fused disconnect.
2. Sub-circuit fusing.
3. Low voltage transformers.
4. Control circuit fusing.
5. Terminal block.
6. Fan motor variable frequency drives.

9.7. Electrical panel must house all high voltage components such as terminal blocks, variable frequency drives, and fuse blocks.
1. Control panel shall include a factory supplied and mounted 115V GFCI convenience outlet receptacle with a 12A circuit breaker. Outlet shall be powered by factory.
2. Unit shall include a factory supplied, mounted, and wired electric heating element in the control panel to maintain a minimum of 0F in the panel.
3. Unit shall include a factory supplied, mounted, and wired phase and voltage monitor.

10. CONTROLS

Coordinate with the control specifications sections 230900 and 230993. The control system will be installed under separate contract between the Owner and Automated Logic (ALC). ERU’s control and control sequence should be coordinated between the manufacturer, ALC and the Owner. Any changes to the ERU’s control shall be executed under the ALC/Owner contract.

10.1. Units shall include factory supplied, mounted, wired, and tested stand-alone microprocessor controls.

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10.2. Microprocessor controller shall be factory-programmed for discharge air control and use an internal 7-day time clock.
10.3. Microprocessor controller shall be mounted in a weather-proof enclosure and accessible without exposing the operator to high voltage wiring or having to turn off or circumvent the main disconnect.
10.4. Microprocessor controller shall include local liquid crystal display (LCD) for user interface.
10.5. The following sensors shall be factory supplied, mounted, and wired inside the unit:
1. Outdoor air humidity sensor.
2. Outdoor air temperature sensor.
3. Evaporator coil leaving air temperature sensor.
4. Supply air filter pressure monitoring.
5. Energy wheel rotation sensor.
10.6. The following devices shall be factory supplied but shipped loose and require field installation and wiring:
1. Wall-mounted room air temperature sensor with manual adjuster. ERU 6 and ERU 7 only.
2. Wall-mounted or return air humidity sensor. ERU 6 and ERU 7 only.
3. Supply air temp temperature sensor. ERU 1 through ERU 5.
4. Wall-mounted CO2 sensor. ERU 6 and ERU 7 only.
5. Space or duct static pressure sensor. ERU 1 through ERU 7.
6. Smoke detectors. ERU 1 through ERU 7.
10.7. Microprocessor controller shall include BACnet MSTP communications for building management system interface.
1. The interface shall make available all available points used in the onboard controller to the BAS system, including any points internal to controller logic. The Owner and BAS contractor shall determine what points will be displayed at the front end.
2. The interface shall make the following points (at a minimum) available for command by the BAS:
2.1. Unit Start / Stop (DO)
2.2. Unit Discharge Setpoint (AO)
2.3. Unit Humidity Setpoint (if unit includes a dehumidification sequence) (AO)
2.4. Unit Pressure Setpoints (space & discharge pressure) (AO)
2.5. Wheel Start/Stop (Ability to lockout or override on) (DO)
3. The ERU provider shall provide a complete sequence of operation detailing the decision process of the internal logic in the controller with respect to temperature, pressure and humidity control. Proprietary sequences for safeties or other non-capacity related logic need not be disclosed.

11. FIELD ACCESSORIES

1. Provide the manufacturers standard flat 14” curb for ERU-5 only. Curb shall be a solid bottom with a minimum of 1” insulation liner for acoustical dampening. The roof curbs shall be minimum 14” above roof decking.

12. FACTORY VERIFICATION TESTING

12.1. Unit shall be run tested prior to shipment from the factory.
12.2. Factory run test report shall be provided at the request of the engineer, contractor, or owner.
12.3. Testing Procedures
1. Unit shall be subjected to and pass a dielectric (hipot) test.
2. All motorized dampers shall be cycled one full stroke while installed in the unit using the factory-provided motorized actuators.
3. Supply fan
3.1. Visually inspect ramp-up, ramp-down, and rotation direction of fan when enabled.
3.2. Verify fan pressure proving switch operation.
3.3. Measure and record current draw through supply fan motor(s).
4. Exhaust fan
4.1. Visually inspect ramp-up, ramp-down, and rotation direction of fan when enabled.
4.2. Verify fan pressure proving switch operation.
4.3. Measure and record current draw through exhaust fan motor(s).
5. Energy recovery wheel.
5.1. Visually inspect energy recovery wheel cassette is free to rotate within cassette.

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5.2. Visually inspect energy recovery belt drive mechanism.
5.3. Enable energy recovery wheel motor and ensure proper rotation.
5.4. Measure and record current draw through energy recovery wheel motor.

6. Refrigeration system
6.1. Measure and record subcooling and superheat on circuit A with hot-gas reheat valve closed (0%) after 15 minutes of steady-state operation.
6.2. Measure and record subcooling and superheat on circuit A with hot-gas reheat valve open (100%) after 15 minutes of steady-state operation.
6.3. Measure and record subcooling and superheat on circuit B after 15 minutes of steady-state operation.

12.4. Test report shall be included with unit and available from the factory upon request.

END OF SECTION

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SECTION 238146

HEAT PUMP SYSTEM, CLOSED CIRCUIT TYPE (GEOTHERMAL SYSTEM)

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide high efficiency heat pump system and equipment as shown on the drawings and in accordance with schedule and specifications.

B. Contractor shall install Owner-provided water-to-air heat pump units where shown on plans and as listed in the schedule. Heat Pump units shall be UL approved and carry UL re-examination marker. All units shall be furnished with random start control to insure staggered morning restart.

C. Basis of design: Trane. The following alternate manufacturers are acceptable if they fully comply with the specifications: Carrier, Water Furnace, McQuay or Florida Heat Pump.

D. Equipment shall be completely assembled, piped, internally wired and computer run tested at the factory. Equipment Manufacturer shall provide computer test results upon request of owner. It shall be both ETL and ISO-ARI 13256-1 Standard ISO (Ground Loop Heat Pump) listed and labeled prior to leaving the factory. Service and caution area labels shall also be placed on the units in their appropriate locations.

E. The manufacturer shall field supervise check, test and start-up of each heat pump. A copy of the manufacturer's start-up and field service report shall be provided to the Mechanical Engineer and Owner.

1.02 SUBMITTALS

A. Submit complete manufacturer's capacity rating data in accordance with ISO – ARI 13256-1 GLHP and under conditions shown on the drawings. Also submit detailed and dimensioned shop drawings of all equipment furnished.

B. Submit shop drawings and product data for manufactured products and assemblies required for this project. Indicate water, drains and electrical rough-in connections on shop drawings. Submit manufacturer’s installation instructions.

C. Operation & Maintenance Data: Submit operation and maintenance data. Include manufacturer’s descriptive literature, operating instruction, installation instructions, and maintenance and repair data.

D. Delivery, Storage, and Handling: Deliver products to site per manufacturer’s standard terms and conditions. Store and protect products per manufacturer’s recommendations. Protect products from physical damage by leaving factory packing cases in place before installation.

E. Submit product data on filtration media highlighting MERV rating.

F. Submit product data on refrigerant. R-410A refrigerant shall be provided.

G. Submit product data on filtration media used during construction and installed prior to occupancy.

1.03 EQUIPMENT WARRANTY

A **two-year parts warranty** shall be provided for any part of the heat pump which becomes defective in normal operation, with an additional parts only **warranty of five years covering replacement of the**

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compressor. Warranty shall commence when the system is totally operable and has been checked and approved by the Engineer.

A **two-year labor warranty** shall be provided by the mechanical contractor.

PART 2 - PRODUCTS

2.01 HIGH EFFICIENCY GROUND SOURCE HORIZONTAL AND VERTICAL WATER SOURCE HEAT PUMPS

A. Manufactured Units: Provide Water Source Heat Pump (WSHP), factory assembled, and pre-wired, consisting of: galvanized steel cabinet with ½-inch fiberglass on interior, front duct discharge collar and back return collar with hinged access filter rack to accommodate 2" thick 40% efficient pleated media filters rated at MERV 8, micro-electronic unit control processor for high and low refrigerant pressure safety control, scroll compressor, water-to-refrigerant coil, thermostatic expansion valve, refrigerant access ports, air-to-air refrigerant coil and motor and fan assembly.

B. Provide four (4) rigid hanging brackets for horizontal, ceiling-mounted units. Hanging bracket shall be capable of receiving rubber isolation and come factory mounted to the unit.

C. Controls:
Coordinate with the control specifications sections 230900 and 230993. The control system will be installed under separate contract between the Owner and Automated Logic (ALC). HPU's control and control sequence should be coordinated between the manufacturer, ALC and the Owner. Any changes to the HPU's control shall be executed under the ALC/Owner contract.

The controller shall provide features listed below:

1. Random start of all water source heat pumps.
2. Anti-short cycle protection shall prevent rapid cycling of the compressor during changeover from heat to cooling or vice-a-versus.
3. Condensate overflow safeties.
4. Fan status and filter timer.
5. Ability to control to four setpoints: occupied, occupied standby, occupied bypass (timed-override) and unoccupied.
6. Illuminated LEDs on the unit controller to show status and diagnostic information: Unit on, alarm conditions and communication status.
7. Provide field service interface for diagnostic and troubleshooting purposes.

D. Below is the list of points that shall be communicated to the building automation system (BAS) from the individual WSHP's via a single twisted-wire pair.

1. Unit status
2. Space setpoint
3. Unit alarms with manual reset include: high pressure, low pressure and condensate overflow.
4. Unit alarms with automatic reset include: fan and filter status and low water temperature.
5. The unit controller shall receive the following commands from the BAS: mode (occupied and unoccupied), demand limiting sequence, emergency shutdown, time-of-day scheduling, "soft" lockout from loss of water flow and high or low water temperature.

E. A scroll compressor shall be provided, externally isolated with internal thermal overload protected motors. All refrigerant lines shall be fully insulated.

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F. Water-to-Refrigerant Heat Exchanger: The water-to-refrigerant heat exchanger shall be of a high quality co-axial coil for maximum heat transfer. The cupro-nickel coil shall be deeply fluted to enhance heat transfer and minimize fouling and scaling. The coil shall have a working pressure of 450 psig on both the refrigerant and water sides. The factory shall provide rubber isolation to the heat exchanging device to enhance sound attenuation.

G. Refrigerant Metering: The equipment shall be provided with a (TXV) terminal expansion valve to allow operation of the unit with entering fluid temperature **from 25F to 125F**.

H. Shrader Connections: The refrigerant access ports shall be factory supplied on the high and low pressure sides for easy refrigerant pressure or temperature testing.

I. Air-to-Refrigerant Coil: The air-to-refrigerant coil shall contain copper tuber mechanically expanded into evenly spaced aluminum fins. All coils are to be leak tested. The proof must be performed at 450 psi operating pressure and the leak test at 125 psi operating pressure with helium.

The refrigerant coil distributor assembly shall be of orifice style with round copper distributor tubes. The tubes shall be sized consistently with the capacity of the coil. Suction headers shall be fabricated from rounded copper pipe.

J. Motor and Fan Assembly:

1. All fan motors shall be ECM. The motor shall have permanently lubricated and sealed bearings. All motors shall have internal thermal overload protection.
2. The fan assembly shall be arranged for front discharge or left discharge. The discharge must also be capable of being changed from front to left or left to front in the field.
3. Removal of the motor and fan wheel shall be made with the assistance of a factory provided orifice ring device. This device shall attach the wheel and motor to the fan housing in one assembly providing single side service access.

K. Filters: Filters shall be 2 inch, 40% efficient MERV 8 rated filters. Two sets total of filters shall be provided to the job.

L. Thermostats: ATC contractor shall provide and install zone sensor with one setpoint and override button.

M. See detail on mechanical drawing for coil hook-up detail.

N. Condensate hose shall extend to the exterior of the casing with a captured, FPT fitting for field piping.

O. Sound Attenuation: The enhanced sound attenuation package shall be applied as a standard feature in the product design. The sound reduction package shall include a vibration isolation to the compressor and water-to-refrigerant coil, a second stage of vibration isolation to the compressor base pan, heavy gauge base assembly, insulated metal compressor enclosure, and maximum sized return-air opening and filler sizing. Unit sound power data shall be included in submittal packet for evaluation. The data shall be rated in accordance with ARI 260. If units other than the basis of design units are provided and a sound problem develops, the contractor shall provide the required sound attenuation at no additional expense to the owner.

PART 3 - INSTALLATION

3.01 WATER CONNECTIONS

A. Manufacturer shall furnish hose lines and all necessary brass fittings for connection of heat pumps to piping runouts as detailed on drawings. Hose shall be Metraflex Elasto-Flex

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Connectors with nontoxic polymer tube with galvanized steel braid and rust resistant connectors - male and female swivel. Hose shall be constructed for 185 psi working pressure and 740 psi burst pressure, -20 to 230F temperature range. Hose lines and fittings shall be installed by Contractor in accordance with manufacturer's recommendations.

B. The Contractor shall install the hose assemblies to temporarily direct from the supply to the return piping where each air conditioner will be located in order to allow circulation of water through the entire pipe loop for thorough flushing of the water system. The Contractor shall flush the entire water loop free of dirt, weld slag and other debris to the Engineer's satisfaction before installing any air conditioner.

C. Each heat pump will have the following piping installation:

1. Supply Slide: Ball valve with pressure/temperature port; two or three foot hose with MPT adapter; strainer with plug blow down and pipe reducer fitting.
2. Return Slide: Ball valve with pressure/temperature port and memory stop; automatic balancing device with two pressure ports; two or three foot hose with MPT adapter and pipe reducer fitting.
3. All WSHP will have a clear vinyl molded “P” trap and condensate hose.

3.02 CLOSED LOOP HEAT PUMP SYSTEM CLEANING AND FLUSHING

A. Circulation start-up before cleaning and flushing:

1. Before the piping system is complete, the contractor shall connect supply and return runouts together at each WSHP location. Connection of supply and return runouts shall be made by the Contractor with short lengths of high pressure rubber hose and brass fittings. One fitting shall be swivel type to eliminate turning fittings in hose.
2. System shall be filled at city water make-up connection, with all air vents open. After filling, vents shall be closed.
3. Contractor shall start main circulator with pressure reducing valve make-up open. Vents shall be checked in sequence to bleed off any trapped air in order to secure circulation through all components of the system.
4. Contractor shall in turn energize supplemental heat source and set control to 90 degrees F., loop temperature. Power must be set off to all heat pumps and heat rejecter motors.

3.03 CLEANING AND FLUSHING THE WATER CIRCULATION SYSTEM

A. Extreme caution shall be exercised by Contractor to prevent dirt and other foreign matter from entering pipes or components of system during construction. Pipe stored on project shall have open ends capped and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting or valve shall be visually examined and all dirt removed.

B. With system filled, circulation established, trapped air vented and supplemental heater on contractor shall check water thermostats installed at key points of system to determine that loop temperature is approximately 90 degrees F. Any leaks in piping shall be repaired before proceeding. Drain at lowest points of system which shall be opened for initial flush and blowdown, making sure city water fill valves are set to make up water at same rate. Check pressure gauge at pump suction and manually adjust make-up to hold same steady positive pressure before and after opening drain valve. Flushing shall continue until clean water is shown leaving open drain. In no case shall flushing period be less than two hours.

C. Supplemental heater and circulation pump shall be shut off. All drains and vents shall be opened to completely drain down system. Short circuited supply and return run-outs at each heat pump shall not be reconnected permanently to respective inlets and outlets on each machine. A commercial brand of Teflon ribbon pipe thread sealer shall be used when making up connections to minimize fouling of tubes.

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D. System shall be refilled for operation under normal closed loop conditions. Contractor shall add trisodium phosphate in an aqueous solution to the system, prepared at proportions of one pound per 50 gallons of water in the system. After system is filled with this solution, the pump should be started, trapped air vented, drains closed and the supplemental heater set for 100 degrees F. (temporary setting for operating control and high limit). Solution shall circulate for approximately three (3) hours. Mechanical Engineer shall be given notice of this cleaning, and, if the Mechanical Engineer's representative deems necessary, the cleaning operation shall be repeated.

E. System shall then be drained completely and refilled with fresh water.

F. After system has been completely cleaned as specified herein, it shall be tested by litmus paper or other dependable method and left on slightly alkaline side (pH 7.5). If system is still on acid side, cleaning by use of trisodium phosphate shall be repeated.

G. Supplemental heater and the high limit control shall be reset at this time.

H. System Additives - the subcontractor shall not add any water treatment chemicals, or at any time "stop-leak" compounds to the system.

3.04 EQUIPMENT MANUFACTURER'S ACKNOWLEDGMENT

The manufacturer of the heat pumps must acknowledge on his submittal data that his equipment will properly interface with all the other systems in the building including the hydronic mechanical system, electrical system and the energy management and temperature controls systems.

HEAT PUMP CONDENSER WATER
PIPING FLUSHING CERTIFICATION

We, the undersigned have witnessed the clearing and flushing of the hydronic heat pump closed loop piping system and certify that the effluent is running clear and free of debris.

Initial Flushing	Trisodium Phosphate Flush
General Contractor	General Contractor
(print) _____	(print) _____
(signed) _____	(signed) _____
(date) _____	(date) _____
Mechanical Contractor	Mechanical Contractor
(print) _____	(print) _____
(signed) _____	(signed) _____
(date) _____	(date) _____
Architect	Architect
(print) _____	(print) _____

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Engineer

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Engineer

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Owner's Representative

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Owner's Representative

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(date) _____

END OF SECTION

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ATTACHMENT “C”

FULL SPECIFICATION SECTIONS (UNDER SEPARATE CONTRACT):
230923 DIRECT – DIGITAL CONTROL SYSTEM FOR HVAC, 230993 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

Section 23 09 00
Instrumentation and Control for HVAC

Arlington Public Schools -

Taylor Elementary School HVAC Renovation

23 09 23 Direct-Digital Control System for HVAC

PART 1: GENERAL

1.1 Products Furnished But Not Installed Under This Section

A. Section 23 09 13.23 - Sensors and Transmitters:
    1. Press and temp sensor wells & sockets
    2. Temp sensor wells and sockets
B. Section 23 09 13.33 - Control Valves:
    1. Control valves

1.2 Products Installed But Not Furnished Under This Section

A. Section 28 31 00 - Fire Detection and Alarm:
    1. Smoke Detectors/Fire Stats

1.3 Products Not Furnished or Installed but integrated with the Work of this Section

- None

1.4 Related Sections

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

1.5 Description

A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
B. The system shall directly control HVAC equipment as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls. Each zone controller shall provide occupied and unoccupied modes of operation by individual zone. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints as specified in the sequence.

C. Control for ERUs shall be via third Party BACnet interface. Interface points (monitoring and control) shall be as shown on the control schematic diagrams and/or the point list. Control devices within the unit envelop shall be factory mounted and test. Devices outside the unit envelope shall be field mounted, checked and commissioned.

1.6 Approved Control Systems

A. The following are approved control system suppliers, manufacturers, and product lines:

Supplier	Manufacturer	Product Line
Automated Logic - Virginia	Automated Logic Corporation	WebCTRL

B. Contact Information: Jeff Smidler, (804) 864-2090, jsmidler@aero-is.com

1.9 System Performance

A. Performance Standards. System shall conform to the established APS standards for WebCTRL systems. The following tables outline the required accuracy of devices.

Table 1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5ºC (±1ºF)
Ducted Air	±0.5ºC (±1ºF)
Outside Air	±1.0ºC (±2ºF)
Dew Point	±1.5ºC (±3ºF)
Water Temperature	±0.5ºC (±1ºF)
Delta-T	±0.15ºC (±0.25ºF)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO_2)	±50 ppm

Note 1: Accuracy applies to 10% - 100% of scale
Note 2: For both absolute and differential pressure
Note 3: Not including utility-supplied meters

Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0ºC (±2.0ºF)	
Duct Temperature	±1.5ºC (±3ºF)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

1.10 Submittals

A. Product Submittal Requirements: Provide shop drawings and other submittals on hardware, software, and equipment to be installed or furnished as electronic (pdf) files. Provide submittals within 6 weeks of receipt of approved mechanical submittals:
   1. Direct Digital Control System Hardware
      a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
      b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for all provided control devices.
      c. Wiring diagrams and layouts for each control panel. Show termination numbers.
      d. Floor plan schematic diagrams indicating controller locations and comm. layout.
   2. Controlled Systems
      a. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
      b. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
      c. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table
      d. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system. List I/O points and software points specified in Section 23 09 93. Indicate alarmed and trended points.

B. Schedules
   1. Adhere to the overall schedule of work. Cooperate in the development of schedules to meet the owners substantial and final occupancy dates.

C. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of standard APS Control As-built packages.

1.11 Warranty

A. Warrant work as follows:
   1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
   2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

3. If Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.12 Ownership Of Proprietary Material

A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
   1. Graphics
   2. Record drawings
   3. Database
   4. Application programming code
   5. Documentation

PART 2: PRODUCTS

2.1 Materials

A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 Communication

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
B. Install new wiring and network devices as required to provide a complete and workable control network. Use existing Ethernet backbone for network segments marked "existing" on project drawings.

2.3 Operator Interface

A. Operator Interface. The system shall connect to the existing APS WebCTRL server.
B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
C. Hardware. None in this project – server is existing.

2.4 Controller Software

A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
B. System Security. See Paragraph 2.3.F.5 (Security) and Paragraph 2.3.F.15.c (Operator Activity).

2.5 Controllers

A. General. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 23 09 23 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified,

hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. BACnet.
    1. All interfaces (if required) shall be BACnet unless specifically stated otherwise.

2.6 Input and Output Interface

A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

2.7 Power Supplies And Line Filtering

A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

2.8 Auxiliary Control Devices

A. Motorized Control Dampers.
    1. Type. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.
        a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
        b. Other modulating dampers shall be opposed-blade.
        c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
    2. Frame. Damper frames shall be 2.38 mm (13 gauge) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminum with reinforced corner bracing.
    3. Blades. Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance. Blades shall be not less than 1.5875 mm (16 gauge).
    4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
    5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 $L/s \cdot m^2$ (10 cfm per ft^2) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).
    6. Sections. Damper sections shall not exceed 125 cm - 150 cm (48 in. - 60 in.). Each section shall have at least one damper actuator.
    7. Linkages. Dampers shall have exposed linkages.

8. Dampers internal to mechanical equipment will be supplied by the equipment vendor following these guidelines.

B. Electric Damper and Valve Actuators.
   1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
   2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
   3. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)
   4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
   5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.

C. Control Valves.
   1. General. Select body and trim materials in accordance with manufacturer's recommendations for design conditions and service shown.
   2. Type. Provide two- or three-way control valves for two-position or modulating service as shown.
   3. Water Valves.
      a. Valves providing two-position service shall be quick opening. Two-way valves shall have replaceable disc or ball.
      b. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide the following minimum close-off pressure ratings.
         i. Two-way: 150% of total system (pump) head.
         ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
      c. Ports. Valves providing modulating service shall have equal percentage ports.
      d. Sizing.
         i. Two-position service: line size.
         ii. Two-way modulating service: select pressure drop equal to the greatest of twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35 kPa (5 psi).
         iii. Three-way modulating service: select pressure drop equal to the smaller of twice the pressure drop through the coil exchanger (load) or 35 kPa (5 psi).
      e. Fail Position. Water valves shall fail normally open or closed as follows unless otherwise specified.
         i. Water zone valves: normally open.
         ii. Heating coils in air handlers: normally open.
         iii. Chilled water control valves: normally closed.

iv. Other applications: as scheduled or as required by sequences of operation.

4. Steam Valves.
   a. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide minimum close-off pressure rating equal to 150% of operating (inlet) pressure.
   b. Ports. Valves providing modulating service shall have linear ports.
   c. Sizing.
      i. Two-position service: select pressure drop equal to 10%-20% of inlet psig.
      ii. Modulating service at 100 kPa (15 psig) or less: select pressure drop equal to 80% of inlet psig.
      iii. Modulating service at 101-350 kPa (16-50 psig): select pressure drop equal to 50% of inlet psig.
      iv. Modulating service at over 350 kPa (50 psig): select pressure drop as scheduled on drawings.

D. Binary Temperature Devices.
   1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
   2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
   3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

E. Temperature Sensors.
   1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
   2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m^2(10 ft^2) of duct cross-section.
   3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
   4. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.
   5. Differential Sensors. Provide matched sensors for differential temperature measurement.

F. Humidity Sensors.
   1. Duct and room sensors shall have a sensing range of 20%-80%.
   2. Duct sensors shall have a sampling chamber.

3. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°C-75°C (40°F-170°F).
4. Humidity sensors shall not drift more than 1% of full scale annually.

G. Relays.
1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

H. Current Transmitters.
1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
3. Unit shall be split-core type for clamp-on installation on existing wiring.

I. Current Switches.
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

J. Pressure Transducers.
1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.
3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.

K. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

2.9 Wiring And Raceways

A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.
C. Class 2 wiring in concealed, accessible areas shall may be plenum rated, run without raceway.
D. Wall runs for zone sensors, etc. on existing walls may be run in wire mould.

PART 3: EXECUTION

3.1 Examination

A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.
B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.
C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 23 09 23 work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.2 Protection

A. Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.
B. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted.

3.3 Coordination

A. Site.
    1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
    2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
B. Test and Balance.
    1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
    2. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.
C. Life Safety.
    1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.
    2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.

3.4 General Workmanship

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

3.5 Field Quality Control

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).
B. Continually monitor field installation for code compliance and workmanship quality.

3.6 Existing Equipment

A. Wiring. Interconnecting control wiring shall be removed and shall become Contractor's property unless specifically noted or shown to be reused.
B. Repair. Unless otherwise directed, Contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Notify Engineer in writing immediately of existing equipment that requires maintenance.

3.7 Wiring

A. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 23 09 23 differ from Division 26, Section 23 09 23 shall take precedence.
B. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.
C. Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.
D. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
E. Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.
F. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.

G. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
H. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.
I. Adhere to requirements in Division 26 where raceway crosses building expansion joints.
J. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
K. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.8 Communication Wiring

A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).
B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

3.10 Installation of Sensors

A. Install sensors according to manufacturer's recommendations.
B. Mount sensors rigidly and adequately for operating environment.
C. Install room temperature sensors on concealed junction boxes properly supported by wall framing.
D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
E. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.
F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m^2 (1 ft^2) of coil area.
G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
H. Install outdoor air temperature sensors on north wall at designated location with sun shield.
I. Differential Air Static Pressure.
    1. Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
    2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.

3. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
5. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
6. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.

J. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.12 Actuators

A. General. Mount actuators and adapters according to manufacturer's recommendations.
B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
    1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
    2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
    3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
    4. Provide necessary mounting hardware and linkages for actuator installation.
C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.

3.14 Identification of Hardware and Wiring

A. Label wiring and cabling, per established owner requirements.
B. Label identifiers shall match record documents.

3.16 Control System Checkout and Testing

A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.

1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 23 09 23.
2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.
7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
8. Alarms and Interlocks.
    a. Check each alarm with an appropriate signal at a value that will trip the alarm.
    b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
    c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

3.17 Control System Demonstration and Acceptance

A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.17 (Control System Checkout and Testing). Provide Engineer with log documenting completion of startup tests.
    1. Engineer will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.
    2. Demonstration shall follow process submitted and approved under Section 23 09 23 Article 1.10 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.
    3. Demonstrate actual field operation of each sequence of operation as specified in Section 23 09 93. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.
    4. Demonstrate compliance with Section 23 09 23 Part 1 (System Performance).
    5. Demonstrate compliance with sequences of operation through each operational mode.

6. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

B. Acceptance.
   1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
   2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 23 09 23 Article 1.10 (Submittals).

3.18 Cleaning

A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.
B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.

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Section 23 09 00
Instrumentation and Control for HVAC

Arlington Public Schools -

Taylor Elementary School HVAC Renovation

23 09 93 Sequence of Operations for HVAC Controls

PART 1: GENERAL

1.0 Section Includes

1.1 Loop Monitor and Pumps

1.2 Two Boiler System

1.3 Single Cooling Tower - Open Circuit

1.4 Water Source Heat Pump

1.5 Enegy Recovery Unit - 1-5

1.6 Enegy Recovery Unit- 6 & 7

1.7 Electric Meter

1.8 Gas Meter

1.9 Water Flow Meter

1.10 Outside Air Conditions

1.11 Point Summary

1.1 Ground Source Loop Monitor and Pumps (typical of 1)

Water Source Heat Pump Loop Monitor - Run Conditions:
The loop monitor shall run whenever:

- Continuously 24/7 to ensure proper field heat transfer.

The following loop water conditions shall be monitored:

- Flow status.
- Supply temperature.
- Return temperature.

Alarms and a heat pump shutdown signal shall be generated upon any of the following loop water conditions:

- No Loop Flow.
- High Loop Water Supply Temp Shutdown: If the loop water supply temperature is greater than 92°F (adj.).
- Low Loop Water Supply Temp Shutdown: If the loop water supply temperature is less than 58°F (adj.).

Alarms shall be provided as follows:

- High Loop Water Supply Temp: If the loop water supply temperature is greater than 90°F (adj.).
- Low Loop Water Supply Temp: If the loop water supply temperature is less than 60°F (adj.).

Loop Water Pump Lead/Lag Operation:
The two loop water pumps shall operate in a lead/lag fashion.

- The lead pump shall run first.
- On failure of the lead pump, the lag pump shall run and the lead pump shall turn off.
- On decreasing loop water differential pressure, the lag pump shall stage on and run in unison with the lead pump to maintain loop water differential pressure setpoint.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- manually through a software switch
- if pump runtime (adj.) is exceeded
- daily
- weekly
- monthly

Alarms shall be provided as follows:

- Loop Water Pump 1

    - Failure: Commanded on, but the status is off.
    - Running in Hand: Commanded off, but the status is on.
    - Runtime Exceeded: Status runtime exceeds a user definable limit.
    - VFD Fault.

- Loop Water Pump 2
    - Failure: Commanded on, but the status is off.
    - Running in Hand: Commanded off, but the status is on.
    - Runtime Exceeded: Status runtime exceeds a user definable limit.
    - VFD Fault.

Loop Water Differential Pressure Control:
The controller shall measure loop water differential pressure and modulate the loop water pump VFDs in sequence to maintain its loop water differential pressure setpoint at each of three locations in the building (Rooms 118, 254 & 277) . The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.

The controller shall modulate loop water pump speeds to maintain a loop water differential pressure of $12lb_f/in^2$ (adj.). The VFD minimum speed shall not drop below 20% (adj.).

On dropping loop water differential pressure, the VFDs shall stage on and run to maintain setpoint as follows:

- The controller shall modulate the lead VFD to maintain setpoint.
- If the lead VFD speed is greater than a setpoint of 90% (adj.), the lag VFD shall stage on.
- The lag VFD shall ramp up to match the lead VFD speed and then run in unison with the lead VFD to maintain setpoint.

On rising loop water differential pressure, the VFDs shall stage off as follows:

- If the VFD speeds then drops back to 60% (adj.) below setpoint, the lag VFD shall stage off.
- The lead VFD shall continue to run to maintain setpoint.

Alarms shall be provided as follows:

- High Loop Water Differential Pressure: If the loop water differential pressure is 25% (adj.) greater than setpoint.
- Low Loop Water Differential Pressure: If the loop water differential pressure is 25% (adj.) less than setpoint.

Loop Bypass Flow Control (Shunt Flow Control)
The overall field flow cannot exceed 450 GPM. The field bypass valve (located in the shunt line) shall modulate to maintain a maximum flow of 450 GPM at the main geothermal flow meter.

New Geothermal Field Control

Each of the 5 new geothermal field circuits shall have a freeze protection circulator pump. This pump shall run to prevent freezing in the circuit manifold whenever the OA temp drops below 35 degrees and there are no zones calling for water flow. The bypass valve shall open whenever the pump is called to run.

Well Field BTU Monitoring

Each of the well fields (1 existing, 5 new) shall be monitored for supply temperature, return temperature and flow. The total BTU supplied by each field shall be calculated.

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Loop Water Supply Temp	×							×		×
Loop Water Return Temp	×							×		×
Loop Water Differential Pressure x 3	×							×		×
Loop Water Pump 1 VFD Speed		×						×		×
Loop Water Pump 2 VFD Speed		×						×		×
Loop Water Pump 1 VFD Fault			×						×	×
Loop Water Pump 2 VFD Fault			×						×	×
Loop Water Pump 1 Status			×					×		×
Loop Water Pump 2 Status			×					×		×
Loop Water Pump 1 Start/Stop				×						×
Loop Water Pump 2 Start/Stop				×						×
Loop Water Differential Pressure Setpoint					×					×
Loop Water Pump 1 Failure									×	
Loop Water Pump 1 Running in Hand									×	
Loop Water Pump 1 Runtime Exceeded									×	
Loop Water Pump 2 Failure									×	
Loop Water Pump 2 Running in Hand									×	
Loop Water Pump 2 Runtime Exceeded									×	
Total Field Flow	×									
Total Field Supply Temp	×									
Total Field Return Temp	×									
Field Bypass Valve		×								
Individual Field Supply Temp (typ of 6)	×									
Individual Field Return Temp (typ of 6)	×									
Individual Field Flow (typ of 6)	×									
Circuit Bypass Isolation Valve (typ of 5)				×						
Circuit Bypass Pump S/S(typ of 5)				×						
Circuit Bypass Pump Status(typ of 5)			×							
Mixing Valve from Central Plant		×								
Total Hardware								**Total Software**		

1.2 Central Plant (2 Boiler & 1 Cooling Tower) (typical of 1)

Central Plant

The central plant acts as supplementary heating and cooling to the well fields. The boilers and cooling tower shall operate in a mutually exclusive fashion.

Central plant pumps shall run in a lead-lag fashion as required to supply supplemental heating or cooling to the main building heat pump loop.

BOILER SECTION

Boiler System Run Conditions:
The boiler system shall be enabled to run whenever:

- A definable number of hot water coils need heating.
- AND outside air temperature is less than 65°F (adj.).
- AND the well field supply temperature is insufficient to meet the heating load in the building.

The boilers shall be enabled by the BAS and shall have the setpoint reset to meet the building heating load. The remainder of boiler controls shall be by the boiler control system.

The boiler shall run subject to its own internal safeties and controls.

Boiler 1 Safeties:
The following safeties shall be monitored:

- Boiler alarm.
- Low water level.

Alarms shall be provided as follows:

- Boiler alarm.
- Low water level alarm.

Boiler 2 Safeties:
The following safeties shall be monitored:

- Boiler alarm.
- Low water level.

Alarms shall be provided as follows:

- Boiler alarm.
- Low water level alarm.

Circulation Pumps:
The Circulation Pumps shall run anytime the associated boiler is called to run and shall have

a user definable delay (adj.) on stop. The pumps shall be called to run, and staged by the internal boiler controls.

Boiler Lead/Standby Operation:
The two boilers shall operate in a lead/standby fashion when called to run and flow is proven.

- The lead boiler shall run first.
- On failure of the lead boiler, the standby boiler shall run and the lead boiler shall turn off.

The designated lead boiler shall rotate upon one of the following conditions: (user selectable):

- manually through a software switch
- if boiler runtime (adj.) is exceeded
- daily
- weekly
- monthly

Alarms shall be provided as follows:

- Boiler 1
    - Failure: Commanded on but the status is off.
    - Running in Hand: Commanded off but the status is on.
    - Runtime Exceeded: Status runtime exceeds a user definable limit.

- Boiler 2
    - Failure: Commanded on but the status is off.
    - Running in Hand: Commanded off but the status is on.
    - Runtime Exceeded: Status runtime exceeds a user definable limit.

- Lead Boiler Failure: The lead boiler is in failure and the standby boiler is on.

Hot Water Supply Temperature Setpoint Reset:
The hot water supply temperature setpoint shall reset using a trim and respond algorithm based on heating requirements.

As the facility's hot water valves open beyond a user definable threshold (90% open, typ.), the setpoint shall reset to a higher value (adj.). Once the hot water coils are satisfied (valves closing) then the setpoint shall gradually lower over time to reduce heating energy user.

Primary Hot Water Temperature Monitoring:
The following temperatures shall be monitored:

- Primary hot water supply.
- Primary hot water return.

Alarms shall be provided as follows:

- High Primary Hot Water Supply Temp: If greater than 200°F (adj.).

- Low Primary Hot Water Supply Temp: If less than 100°F (adj.).

Boiler 1 Hot Water Temperature Monitoring:
The following temperatures shall be monitored:

- Boiler 1 hot water supply.
- Boiler 1 hot water return.

Alarms shall be provided as follows:

- High Hot Water Supply Temp: If greater than 200°F (adj.).
- Low Hot Water Supply Temp: If less than 100°F (adj.).

Boiler 2 Hot Water Temperature Monitoring:
The following temperatures shall be monitored:

- Boiler 2 hot water supply.
- Boiler 2 hot water return.

Alarms shall be provided as follows:

- High Hot Water Supply Temp: If greater than 200°F (adj.).
- Low Hot Water Supply Temp: If less than 100°F (adj.).

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Primary Hot Water Return Temp	×							×		×
Primary Hot Water Supply Temp	×							×		×
Boiler 1 Hot Water Return Temp	×							×		×
Boiler 1 Hot Water Supply Temp	×							×		×
Boiler 2 Hot Water Return Temp	×							×		×
Boiler 2 Hot Water Supply Temp	×							×		×
Boiler 1 Hot Water Supply Temp Setpoint Reset		×						×		×
Boiler 2 Hot Water Supply Temp Setpoint Reset		×						×		×
Boiler 1 Alarm Status			×					×	×	×
Boiler 1 Low Water Level			×					×	×	×
Boiler 2 Alarm Status			×					×	×	×
Boiler 2 Low Water Level			×					×	×	×
Hot Water Pump Status			×					×		×
Circulation Pump Status (typ of 4)			×					×		×
Boiler 1 Status			×					×		×
Boiler 2 Status			×					×		×
Hot Water Pump Start/Stop				×				×		×
Boiler 1 Enable				×						×
Boiler 2 Enable				×						×

	Hardware Points				Software Points					
Point Name	AI	AO	BI	BO	AV	BV	Sched	Trend	Alarm	Show On Graphic
Boiler 1 Failure									×	
Boiler 2 Failure									×	
Boiler 1 Running in Hand									×	
Boiler 2 Running in Hand									×	
Lead Boiler Failure									×	×
Boiler 1 Runtime Exceeded									×	
Boiler 2 Runtime Exceeded									×	
High Primary Hot Water Supply Temp									×	
Low Primary Hot Water Supply Temp									×	
Boiler 1 High Hot Water Supply Temp									×	
Boiler 1 Low Hot Water Supply Temp									×	
Boiler 2 High Hot Water Supply Temp									×	
Boiler 2 Low Hot Water Supply Temp									×	

COOLING TOWER SECTION

Cooling Tower - Run Conditions:
The cooling tower shall be enabled to run whenever the outside air temperature is greater than 54°F (adj.).

Vibration Switch:
The cooling tower shall shut down and an alarm generated upon receiving a vibration switch status.

Condenser Water Pump:
The lead condenser water pump shall run anytime the cooling tower is called to run. The lag condenser water pump shall start on lead pump failure.

The condenser water pump shall start prior to the CT being enabled and shall stop only after the CT is disabled. The condenser water pump shall therefore have:

- A user adjustable delay on start.
- AND a user adjustable delay on stop.

Alarms shall be provided as follows:

- Condenser Water Pump Failure: Commanded on, but the status is off.
- Condenser Water Pump Running in Hand: Commanded off, but the status is on.
- Condenser Water Pump Runtime Exceeded: Status runtime exceeds a user definable limit.

Cooling Tower VFD Fan - Condenser Water Temperature Control:
The controller shall measure the cooling tower condenser water supply (basin) temperature and modulate the bypass valve and fan VFD in sequence to maintain setpoints.

The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.

On rising condenser water supply temperature, the controller shall modulate the bypass valve to maintain setpoint of 78°F (adj.) and the fan VFD to maintain setpoint of 82°F (adj.).

Alarms shall be provided as follows:

- Fan
  - Failure: Commanded on, but the status is off.
  - Running in Hand: Commanded off, but the status is on.
  - Runtime Exceeded: Status runtime exceeds a user definable limit.
  - VFD Fault.

- High Condenser Water Supply (Basin) Temp: If greater than 86°F (adj.).
- Low Condenser Water Supply (Basin) Temp: If less than 38°F (adj.).

Condenser Water Temperature Monitoring:
The following temperatures shall be monitored:

- Condenser water supply temperature.
- Condenser water return temperature.

Alarms shall be provided as follows:

- High Condenser Water Supply Temp: If the condenser water supply temperature is greater than 86°F (adj.).
- Low Condenser Water Supply Temp: If the condenser water supply temperature is less than 65°F (adj.).

- High Condenser Water Return Temp: If the condenser water return temperature is greater than 100°F (adj.).
- Low Condenser Water Return Temp: If the condenser water return temperature is less than 75°F (adj.).

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Condenser Water Supply (Basin) Temp	×							×		×
Condenser Water Return Temp	×							×		×
Condenser Water Supply Temp	×							×		×
Fan VFD Speed		×						×		×
Vibration Status			×					×	×	×
Condenser Water Pump 2 Status			×					×		×
Condenser Water Pump 2 Status			×					×		×
Fan Status			×					×		×
Fan VFD Fault			×						×	×
Condenser Water Pump Start/Stop				×						×

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Condenser Water Pump Start/Stop				×				×		×
Fan Start/Stop				×						×
Outside Air Temp					×					×
Condenser Water Pump Failure									×	
Condenser Water Pump Running in Hand									×	
Condenser Water Pump Runtime Exceeded									×	
Low Condenser Water Supply (Basin) Temp									×	
High Condenser Water Supply (Basin) Temp									×	
Fan Failure									×	
Fan in Hand									×	
Fan Runtime Exceeded									×	
High Condenser Water Return Temp									×	
Low Condenser Water Return Temp									×	
High Condenser Water Supply Temp									×	
Low Condenser Water Supply Temp									×	

1.4 Water Source Heat Pump (typical of 1)

Run Conditions - Scheduled:
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
  - A 74°F (adj.) cooling setpoint
  - A 70°F (adj.) heating setpoint

- Unoccupied Mode (night setback): The unit shall maintain
  - A 85°F (adj.) cooling setpoint.
  - A 55°F (adj.) heating setpoint.

Alarms shall be provided as follows:

- High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
- Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

Zone Setpoint Adjust:
The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Zone Optimal Start:
The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

Zone Unoccupied Override:
A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

Fan:
The fan shall run anytime the unit is commanded to run, unless shutdown on safeties.

Heating and Cooling - 1 Compressor Stage:
The controller shall receive a signal from the loop water source monitor indicating that there is water flow and that the water temperature is within acceptable limits.

The controller shall measure the zone temperature and cycle the compressor to maintain its setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime. The compressor shall run subject to its own internal safeties and controls.

The heating shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the fan is on.
- AND the reversing valve is in heat mode.

The cooling shall be enabled whenever:

- Outside air temperature is greater than 60°F (adj.).
- AND the fan is on.
- AND the reversing valve is in cool mode.

On mode change, the compressor shall be disabled and remain off until after the reversing valve has changed position.

Alarms shall be provided as follows:

- Compressor Runtime Exceeded: The compressor runtime exceeds a user definable limit (adj.).

Filter Hours:
The controller shall monitor the fan runtime.

Alarms shall be provided as follows:

- Filter Change Required: Filter has been in use for more than 2200hr (adj.).

Discharge Air Temperature:
The controller shall monitor the discharge air temperature.

Alarms shall be provided as follows:

- High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
- Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

Unit Status:
The controller shall monitor the unit status via a current transmitter on the incoming AC power. The system shall establish a baseline amp draw for the fan so that upon an increase above this baseline, the draw of the compressor is shown.

Alarms shall be provided as follows:

- Fan Failure: Commanded on, but the status is off.
- Fan in Hand: Commanded off, but the status is on.
- Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

Environmental Index:
When the zone is occupied, the controller will monitor the deviation of the zone temperature from the heating or cooling setpoint and calculate a 0 - 100% *Environmental Index* which gives an indication of how well the zone is maintaining comfort. The controller will also calculate the percentage of time since occupancy began that the Environmental Index is 70%

or higher. Optionally, a weighting factor can be configured to adjust the contribution of the zone to the rollup average index based upon the floor area of the zone, importance of the zone, or other static criteria.

Aux Pan Status:
The controller shall monitor the aux pan water level. The unit shall be shut down if aux pan level sensor is tripped. Alarms shall be provided as follows:

- Pan Alarm: Water in pan, unit commanded off.

Isolation Valve:
The unit isolation valve shall be closed when the unit is commanded off.

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	×							×		×
Zone Setpoint Adjust	×									×
Discharge Air Temp	×							×		×
Unit Fault			×					×		×
Zone Override			×					×		×
Unit Status			×					×		×
Pan Alarm			×					×	×	×
Fan Start/Stop				×				×		×
Compressor Start/Stop				×				×		×
Reversing Valve				×						×
Heating Stage 1				×				×		×
Shutoff Valve				×				×	×	×
Environmental Index					×			×		
Percent of Time Satisfied					×			×		
Compressor Soft Shutdown						×				×
Schedule							×			
Heating Setpoint								×		×
Cooling Setpoint								×		×
High Zone Temp									×	
Low Zone Temp									×	
Compressor Runtime Exceeded									×	
Filter Change Required									×	
High Discharge Air Temp									×	
Low Discharge Air Temp									×	
Fan Failure									×	
Fan in Hand									×	
Fan Runtime Exceeded									×	
Totals	**4**	**0**	**3**	**5**	**2**	**1**	**1**	**14**	**13**	**15**

Total Hardware (12) **Total Software (31)**

1.5 Enegy Recovery Unit - 1-5 & 6-7 (typical of 7)

The energy recovery units shall run on their own internal controls. The BAS shall command the unit enable and reset the unit discharge setpoints. Additionally, the BAS shall have the ability to override the start/stop and speed of the fans and the position of the dampers.

The sequence shall be by the unit manufacturer.

Units 1-5 shall control for values (T,H & CO2) measured in the return air, units 6 & 7 shall control for values in the space.

Factory Point List

Object Name	Object Type	Description	Writeable
CoolCoilTemp	Analog Value	Calibrated Cooling Coil Temp	no
OutdoorRH	Analog Value	Outdoor Air Relitive Humidity	no
SpaceRH	Analog Value	Space Relitive Humidity	no
SpaceTemp	Analog Value	Space Temperature	no
SupplyAirTemp	Analog Value	Supply Air Temperature	no
HotGasOutput	Analog Value	Hot Gas Reheat Valve Position	no
SupCoolingSP	Analog Value	Supply Cooling Setpoint	Yes
SupHeatingSP	Analog Value	Supply Heating Setpoint	Yes
UnOccClgSp	Analog Value	Night Cooling Setpoint	Yes
Compr1SS	Binary Value	Compresor 1 Start Stop	no
Compr2SS	Binary Value	Compresor 2 Start Stop	no
Compr3SS	Binary Value	Compresor 3 Start Stop	no
Compr4SS	Binary Value	Compresor 4 Start Stop	no
OccSchedule	Binary Value	Net In Schedule	Yes
ElectricHeat	Analog Value	Electric Heat Percentage	no
ModGasHeat	Analog Value	Modulating Heat Percentage	no
FanOutput	Analog Value	Supply Fan Speed	no
DehumidMode	Binary Value	Dehumidification Mode	no
in_alarm	Binary Value	Alarm Output	no
FilterStatus	Binary Value	Filter Status	no
OADamper	Analog Value	Outside Damper Position	no
DamperOpen	Binary Value	OA Damper End Switch	no
ExhaustFanStat	Binary Value	Exhaust Fan Status	no
ExhaustFanSS	Binary Value	Exhaust Fan Start Stop	no
HeatWheelSS	Binary Value	Heat Wheel Start Stop	no
ExhaustFanSpeed	Analog Value	Exhaust Fan VFD Speed	no
ResetLockout	Binary Value	Reset After Alarm Lockout	Yes
OutdoorTemp	Analog Value	Outdoor Air Temperature	no
RunStopInput	Binary Value	Shutdown Input	no
SpaceStaticPress	Analog Value	Space Static Pressure	no
LowLimit	Binary Value	Low Limit Output	no
EF_Alarm	Binary Value	Exhaust Fan Alarm	no
NetFanSpeed	Analog Value	Net Fan Speed	Yes
SF_SS	Binary Value	Supply Fan Start Stop	no
CO2	Analog Value	Space CO2	no
MinOADamperPos	Analog Value	Minimum Outside Air Damper Position	Yes
Duct Static SP	Analog Value	Duct Statis Pressure Setpoint	Yes
SpaceStaticSP	Analog Value	Space Static Pressure Setpoint	Yes
OADewptStpt	Analog Value	Outside Air Dewpoint Setpoint	Yes

EF_VFD_Offset	Analog Value	Exhaust Fan VFD Offset	Yes
Setpoint	Analog Value	Occupied Space Setpoint	Yes
SpaceRHSetPt	Analog Value	Space Humidity Setpoint	Yes
UnOccDewptSP	Analog Value	UnOccupied Dewpoint Setpoint	Yes
UnOccRHsetpt	Analog Value	UnOccupied Humidity Setpoint	Yes
NetSpaceTemp	Analog Value	Space Temperature Input	Yes
NetSpaceRH	Analog Value	Space RH Input	Yes
HWFrstPrtctSP	Analog Value	Heat Wheel Frost Protect Setpoint	Yes
NetSpaceCO2	Analog Value	CO2 From Network	Yes
CO2_Sp	Analog Value	CO2 High Limit Setpoint	Yes
NetStatic	Analog Value	Network Static Pressure	Yes
SpaceEnth	Analog Value	Space Enthalpy	no
OADewpoint	Analog Value	Outside Air Dewpoint	no
OAEnthalpy	Analog Value	Outside Air Enthalpy	no
DuctStaticPress	Analog Value	Duct Static Pressure	no
ExhaustTemp	Analog Value	Exhaust Air Temp	no
DigitalScroll	Analog Value	Digital Scroll Output	no
HPWaterVlv_A	Analog Value	Heat Pump Water Valve A	no
HPWaterVlv_B	Analog Value	Heat Pump Water Valve B	no
EffectSetPt	Analog Value	Effective Setpoint	no
FanStatus	Binary Value	Fan Status	no
HghLwPressCtA	Binary Value	High Low Press Coutout Ct A	no
HghLwPressCtB	Binary Value	High Low Pressure Cutout Ct B	no
EffectOccup	Binary Value	Occupancy State	no
GasHeatEna	Binary Value	Modulating Gas Heat Enable	no
GasHeatEnaStg2	Binary Value	Gas Heat Enable Stage Two	no
SF_Alarm	Binary Value	Supply Fan Alarm	no
EconoLockout	Binary Value	Economizer Enable	Yes
CO2_DamperPos	Analog Value	High CO2 Max Damper Pos	Yes
UnnOccHtgSP	Analog Value	Unoccupied Heating Setpoint	Yes
AFMS_Setpoint	Analog Value	IAQ Damper Setpoint	Yes
AFMS	Analog Value	Air Flow Measuring Station	no
IAQdamperPos	Analog Value	IAQ Damper position	no
Alarm Code	Analog Value	Alarm Code Output	no
HW_VFD_Speed	Analog Value	Heat Wheel VFD Speed	no
NetOAT	Analog Value	Outside Air Temp From Network	Yes
NetOARH	Analog Value	Outside Air Humidity From Network	Yes
HX_FnB_Damper	Analog Value	Flat Plate Heat Exchanger Damper Position	no
NetDuctStatic	Analog Value	Duct static pressure input from network	Yes
ChilledWtrVlv	Analog Value	Chilled Water Valve Position	no
HPCktA_Tmp	Analog Value	Heat Pump Circut A Temperature	no
HPCktB_Temp	Analog Value	Heat Pump Circut B Temperature	no
MixeAirTemp	Analog Value	Mixed Air Temperature	no
HeadPressDO	Binary Value	Head Pressure Digital Output	no
ReversingVlv	Binary Value	Heat Pump Reversing Valve	no
HeadPressVFD	Analog Value	Head Pressure VFD Speed	no

1.7 Electric Meter (typical of 1)

Electric Meter:
The controller shall monitor the electric meter for electric consumption on a continual basis. These values shall be made available to the system at all times.

Alarm shall be generated as follows:

- Meter Failure: Sensor reading indicates a loss of pulse output from the electric meter.

Peak Demand History:
The controller shall monitor and record the peak (high and low) demand readings from the electric meter. Peak readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Usage History:
The controller shall monitor and record electric meter readings so as to provide a power consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Demand Levels:
The controller shall set the system demand level (adj.) based on the current power consumption readings from the electric meter. There shall be six daily time periods in which the demand shall be adjusted on three levels. These demand levels shall be available for facility equipment to utilize for demand limiting.

- Demand Level 1: Power consumption has exceeded the first demand level threshold (adj.).
- Demand Level 2: Power consumption has exceeded the second demand level threshold (adj.).
- Demand Level 3: Power consumption has exceeded the third demand level threshold (adj.).

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
kW Pulse	×									×
Current Demand Level					×					×
kW Demand								×		×
kW Peak Today								×		×
kW Peak Month-to-Date								×		×
kW Peak Year-to-Date								×		×
kWh Today								×		×
MWh Month-to-Date								×		×
MWh Year-to-Date								×		×
Meter Failure									×	
Demand Level 1									×	

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Demand Level 2									×	
Demand Level 3									×	
Totals	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**7**	**4**	**9**

Total Hardware (1) **Total Software (12)**

1.8 Gas Meter (typical of 1)

Gas Meter:
The controller shall monitor the gas meter for gas consumption on a continual basis. These values shall be made available to the system at all times.

Alarm shall be generated as follows:

- Meter Failure: Sensor reading indicates a loss of pulse output from the gas meter.

Peak Demand History:
The controller shall monitor and record the peak (high and low) demand readings from the gas meter. Peak readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Usage History:
The controller shall monitor and record gas meter readings so as to provide a gas consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Gas Flow Rate	×									
Demand								×		×
Peak Today								×		×
Peak Month-to-Date								×		×
Peak Year-to-Date								×		×
Usage Today								×		×
Usage Month-to-Date								×		×
Usage Year-to-Date								×		×
Meter Failure									×	
Totals	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**1**	**7**

Total Hardware (1) **Total Software (8)**

1.9 Water Flow Meter (typical of 1)

Water Meter:
The controller shall monitor the water meter for water consumption on a continual basis. Monitoring shall be accomplished via a MODBUS interface to the utility meter (meter devices, including wireless devices by others).

Alarm shall be generated as follows:

- Meter Failure: Sensor reading indicates a loss of pulse output from the water meter.

Peak Demand History:
The controller shall monitor and record the peak (high and low) demand readings from the water meter. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Usage History:
The controller shall monitor and record water meter readings so as to provide a water consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Water Flow Rate	×									
Demand								×		×
Peak Today								×		×
Peak Month-to-Date								×		×
Peak Year-to-Date								×		×
Usage Today								×		×
Usage Month-to-Date								×		×
Usage Year-to-Date								×		×
Meter Failure									×	
Totals	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**1**	**7**

Total Hardware (1) **Total Software (8)**

1.10 Outside Air Conditions (typical of 1)

Outside Air Conditions:
The controller shall monitor the outside air temperature and humidity and calculate the outside air enthalpy on a continual basis. These values shall be made available to the system at all times.

Alarm shall be generated as follows:

- Sensor Failure: Sensor reading indicates shorted or disconnected sensor. In the event of a sensor failure, an alternate outside air conditions sensor shall be made available to the system without interruption in sensor readings.

If an OA Temp Sensor cannot be read, a default value of 65°F will be used.

If an OA Humidity Sensor cannot be read, a default value of 50 % will be used.

Outside Air Temperature History:
The controller shall monitor and record the high and low temperature readings for the outside air. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Outside Air Temp	×							×		×
Outside Air Humidity	×							×		×
Outside Air Enthalpy					×			×		×
High Temp Today								×		×
High Temp Month-to-Date								×		×
High Temp Year-to-Date								×		×
Low Temp Today								×		×
Low Temp Month-to-Date								×		×
Low Temp Year-to-Date								×		×
Sensor Failure									×	
Totals	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**9**	**1**	**9**

Total Hardware (2) **Total Software (11)**

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